PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

COMMONWEALTH MYCOLOGICAL INSTITUTE
22 JUN 1949

XXXIII (1947)

PART I: BOTANY AND FORESTRY

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

VOLUME XXXIII (1947)

PART I: BOTANY AND FORESTRY

VOLUME XXXIII IS AVAILABLE IN FOUR PARTS:

PART I: BOTANY AND FORESTRY

PART II: ZOOLOGY

PART III: GEOGRAPHY AND GEOLOGY

PART IV: GENERAL SECTION

ANTHROPOLOGY, ECONOMICS
HISTORY AND POLITICAL SCIENCE
LANGUAGE AND LITERATURE
MEDICAL SCIENCE, SOCIOLOGY

PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS
EUGENE S. McCARTNEY
FREDERICK K. SPARROW

VOLUME XXXIII (1947)

PART I: BOTANY AND FORESTRY

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

ANN ARBOR: THE UNIVERSITY OF MICHIGAN PRESS
LONDON: GEOFFREY CUMBERLEGE, OXFORD UNIVERSITY PRESS
1949

All rights reserved

COPYRIGHT, 1949,
BY THE UNIVERSITY OF MICHIGAN

Set up and printed,
February, 1949

PRINTED IN THE UNITED STATES OF AMERICA
BY E. L. HILDRETH AND CO. • BRATTLEBORO • VERMONT

CONTENTS

BOTANY

PAGE

Studies in the Genus Poria. III. White and Brightly Colored Species. Josiah L. Lowe 3

FORESTRY

Some Resupinate Polypores from the Region of the Great Lakes. XIX. Dow V. Baxter 9

Forestry in Soil Conservation. Albert F. Dodge 31

Some Results of Selection Cutting in the Eber White Woods, Ann Arbor, Michigan. Leigh J. Young and Harold F. Scholz ... 39

ILLUSTRATIONS

PLATES

FACING PAGE

Baxter: Pls. I–IX. Resupinate polypores from the region of the Great Lakes 30

BOTANY

STUDIES IN THE GENUS PORIA

III. WHITE AND BRIGHTLY COLORED SPECIES *

JOSIAH L. LOWE

THIS paper is a continuation of the writer's studies of type specimens or other authentic or interesting material of Poria. For this series type collections of sixteen species were studied, of which thirteen are reduced to certain or probable synonymy, and two are recognized as distinct; for one of these further distribution records are presented. The writer is indebted to the directors of the following herbaria for the privilege of studying specimens under their care: Kew Herbarium, Surrey, England; the New York Botanical Garden, New York City, New York; the Farlow Reference Library and Cryptogamic Herbarium, Cambridge, Massachusetts; and the Mycological Collections, Bureau of Plant Industry, Beltsville, Maryland.

Poria alabamae (Berk. and Cooke) Cooke. — This species has been compared with *Poria unita* (Pers.) Karst. and its allies by a number of writers, and was placed in synonymy with *P. unita* by Overholts (4). The external appearance and all internal characters agree closely except that the spores of *P. alabamae* are hyaline, smooth, oblong with rounded ends, 8–13 × 3.5–4.5 μ (or 10–12 × 4–5 μ by Bresadola's measurement, as indicated by annotations on the type sheet [at Kew]), whereas those of *P. unita* are oblong-ellipsoid to oval or subglobose, 4–7 × 2.5–5 μ. The spore shape of *P. alabamae* is wholly different from that of species in the *Poria unita* complex, and the species is probably not closely related to any member of that complex. A complete description of *P. alabamae* is supplied:

Annual, probably rather widely effused. Margin nearly white, up to

* Contribution from the Department of Forest Botany and Pathology, The New York State College of Forestry, Syracuse, New York.

The first of the studies was published in these *Papers*, 32: 99–101. 1948; the second, in *Lloydia*, 10: 45–59. 1947.

1 mm. wide, soft-fibrous or in part glazed. Pore surface light buff, the tubes soft, waxy-corky, up to 1 mm. long, the mouths rounded, averaging 4 per mm., the edge rather narrow, entire. Subiculum light buff, up to 0.5 mm. thick, soft spongy-fibrous. Sections not changing color in KOH, the subiculum hyphae closely interwoven, difficultly separable by pressure, 2–2.5 μ in diameter, nonseptate, the walls thick to solid; trama continuous with the subiculum and of similar hyphae. Cystidia none; basidia 11 μ in diameter; spores (not seen attached to basidia) hyaline, smooth, oblong with rounded ends, 8–13 × 3.5–4.5 μ (or 10–12 × 4–5 μ by Bresadola's measurements).

Known only from the type collection, Gainesville, Florida, Ravenel 102. Collections subsequently reported under this name have not been examined.

Poria albo-lutea Bourd. and Galz.—Material agreeing with published descriptions was collected in 1945 for the first time in North America, at Chapel Hill, North Carolina (Lowe 2867, 2910, 2936).

Poria aurantiaca var. *saloisensis* (Karst.) Sacc.—This variety was described from a collection in Finland and later referred to synonymy with *Poria nitida* (Pers.) Cooke by Bresadola (2, p. 77), and to synonymy with *P. aurantiaca* (Rostk.) Sacc. by Bourdot and Galzin (1) and Pilát (6). Authentic specimens of these two species have not been available for examination, but it has been established that the variety recognized by Karsten is the same as the fungus recently described by Overholts and Lowe (5) as *Poria rubens*. A specimen collected in Finland by Karsten and now in the New York Botanical Garden agrees in all respects with type material of *P. rubens*, as does a specimen in the Farlow Herbarium from the Tirol, determined as "*P. placenta*" by Litschauer.

Poria placenta (Fries) Cooke and *P. aurantiaca* var. *saloisensis* have frequently been confused in the past, but can readily be separated. The first has spores 4.5–6 × 1.5–2 μ, and the subiculum hyphae lack clamp connections, although the hyphae are septate. The latter has spores 3.5–5 × 2–2.5 μ, and the hyphae have clamps. The only known North American collection of *P. placenta* is from Isle Royale, Michigan; E. T. and S. A. Harper 1016 (Farlow Herbarium; and Mycological Collections, Bureau of Plant Industry).

Poria argillacea Cooke was based on two collections (now at Kew) from California, one of which, on wood of *Pinus lambertiana* Dougl.,

seems to be the same as *P. aurantiaca* var. *saloisensis*. It is sterile, however, and certain determination cannot be made. The other collection, on oak, is also sterile and is in such poor condition that its identity probably cannot be determined.

Poria beaumontii Berk. and Curt.—The type material (at Kew) is sterile and its identity is uncertain. Otherwise it agrees well with *Poria tenuis* (Schw.) Cooke.

Poria cincinnati Berk.—Although sterile, the type material (at Kew) agrees perfectly in all other characteristics with *Polyporus tulipiferus* (Schw.) Overh.

Poria dryina (Berk. and Cooke) Cooke.—The type material (at Kew) seems to be the same as *Poria cremor* (Berk. and Curt.) Cooke and *P. limitata* (Berk. and Curt.) Cooke, and hence is very doubtfully distinct from *Poria unita*. Final decision on all these species and on *P. holoxantha* Berk. and Cooke should be made by comparing the types with adequate material collected in the type localities by a competent collector.

Poria fagicola Bres.—The type collection (Weir 19070) does not appear to differ from type material of *Poria semitincta* (Peck) Cooke or *Poria fatiscens* (Berk. and Rav.) Cooke. The latter is the valid name for this fungus.

Poria fuscomarginata Berk.—The type material (at Kew) does not appear to differ from *Poria subacida* (Peck) Sacc.

Poria holoseparans Murr.—Although the type material which was studied is sterile it does not appear to differ from *Poria undata* (Pers.) Bres.

Poria holoxantha Berk. and Cooke.—The type material (at Kew) is the same as *Poria cremor*, *P. dryina*, and *P. limitata*, and thus is doubtfully distinct from *Poria unita*.

Poria incrustans (Berk. and Curt.) Cooke.—The identity of this plant is still uncertain, since the type collection is sterile. Exactly similar additional material from Virginia (Overholts Herbarium 4007, coll. A. S. Rhoads), and from Vermont (Farlow Herbarium, coll. E. A. Burt) has been examined. The Vermont collection, which is fertile, has spores that are hyaline, smooth, oblong-ellipsoid, 4–5 × 3–3.5 μ.

Poria millavensis Bourd. and Galz.—The collection reported by Overholts (3) from Vermont does not appear to agree with the description of that species given by Bourdot and Galzin (1), since the spores

are not subglobose. Although the colors of the fresh plant are unknown and although this specimen shows no rhizomorphs, all other characteristics are those of *Poria subradiculosa* Murr.

Poria omaema Berk. — The type collection (at Kew) does not differ from *Poria subacida* (Peck) Sacc.

Poria rhoadsii Murr. — This does not appear to differ from type material of *Poria phlebiaeformis* Berk. deposited in the Farlow Herbarium. The latter seems to be a valid species and not a synonym of *Poria spissa* (Schw.) Cooke, as sometimes indicated.

Poria similis Bres. — This species, described from Idaho, also occurs in the eastern United States, and specimens have been examined from Pennsylvania (Overholts Herbarium 8652), Ohio (Morgan 133), Michigan (A. H. Smith 1152; C. H. Kauffman, three collections), and Missouri (Demetrius, New York State Museum Herbarium).

Poria sulphurella (Peck) Sacc. — A recent reëxamination of the type collection shows that this species does not differ from *Poria xantha* (Fries) Cooke.

Poria tegillaris Berk. — The type material (at Kew) is sterile and so poorly developed that it seems improbable that its identity can be determined. The species should be dropped from further consideration.

Poria tomentocincta Berk. and Rav. — The type material (at Kew) does not appear to differ from *Poria pulchella* (Schw.) Cooke.

The New York State College of Forestry
Syracuse, New York

LITERATURE CITED

1. Bourdot, H., and Galzin, A. 1927. Hyménomycètes de France, iv + 761. Paris.
2. Bresadola, J. 1903. Fungi polonici. Ann. Mycol., 1: 65–131.
3. Overholts, L. O. 1939. New or Little-Known Species of Poria. Proc. Pa. Acad. Sci., 13: 121–125.
4. —— 1942. Polyporaceae of Pennsylvania. The Genus Poria. Pa. Agric. Exper. Sta. Bull. 418, 64 pp.
5. —— and Lowe, J. L. 1946. New Species of Poria. Mycologia, 38: 202–212.
6. Pilát, A. 1936–42. Atlas des Champignons de l'Europe. Tome III. Polyporaceae I, 624 pp. Praha.

FORESTRY

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES. XIX*

DOW V. BAXTER

RESUPINATE polypores from the region of the Great Lakes occur generally throughout the North American continent. *Poria borbonica, Poria heteromorpha,* and a very few other species have not been collected in this area and are not likely to be.

Since the first paper of this series was published (1927)[1] field work has been conducted throughout the continent from the Arctic Ocean and Bering Sea areas in Alaska through the Yukon Territory and the Northwest Territories and all the Canadian provinces to the colony of Newfoundland. Numerous records of both distribution and substrata have been added since many of the accounts appeared.[2] Likewise, additional information has been obtained in the laboratory relative to the features of many of these fungi in culture.

Paper 19 presents the reactions of *Poria ferox* Long and Baxter (Paper 11 of this series), *Fomitiporella melleopora* (Paper 18 of this series), and *Fomes Earlei* in culture. Additional accounts of resupinate polypores are given, and two new species are described.

* Throughout the work on these monographs I have been indebted to many individuals and institutions for suggestions, help, and privileges extended to me. My appreciation is expressed particularly to the men who have accompanied me on my ten expeditions to Alaska, the Yukon Territory, the Northwest Territories, Newfoundland, and Labrador. They aided me in the collection and care of specimens and at times lived under rather difficult circumstances. I am under obligation to Professor T. G. Halle, of Naturhistoriska Riksmuséet in Stockholm, with whom I have had the pleasure of association. Thanks are due several American institutions and scholars also. To the authorities at the New York Botanical Garden, to Dr. W. H. Long, Albuquerque, New Mexico, to the staff of the Division of Pathological and Mycological Collections of the United States Department of Agriculture, and to Professor H. H. Bartlett, of the University of Michigan, I am especially indebted.

[1] All these articles have appeared in the *Papers of the Michigan Academy.*

[2] Ultimately these early records will be revised so as to incorporate the new information obtained on the various expeditions, as well as in the laboratory, and will be published under the title "The Resupinate Polypores of North America."

The color terms given within quotation marks are those of R. Ridgway, *Color Standards and Color Nomenclature* (Washington, 1912).

Poria quercuum sp. nov.

(Plate I)

Type specimen.—*Poria quercuum* sp. nov. on *Quercus stellata*, Branson, Missouri, February 5, 1947. Dow V. Baxter. Herb. Dow V. Baxter, Ann Arbor.

Fructificatio albida, annua, per maculas irregulares usque ad 30 cm. effusa, siccitate fragilis separabilisque, coriacea, plerumque 2–3 mm. crassa; marginibus c. 1 mm. latis, juventate albis, tomentosis, aetate fertilibus, pallide ochraceis; subiculo albido, saepissime minus quam 0.3 mm., inconspicuo, in plantis vetustis saepe nullo; tubis 2–3 mm. longis, diametro plerumque 3 (vel raro 2) per spatium 1 mm., parietibus crassis, primum albidis demum similibus (in speciminibus herbariorum cito siccatis) vel plus minusve pallide ochraceis vel flavidis in speciminibus naturalibus siccis, aspectu cretaceis sed firmis; sporis laevibus, hyalinis, allantoideis, 3.5–4 μ longis, 1 μ latis; hyphis hyalinis, 2–4 μ (plerumque 3–4 μ) diametientibus.

Fructification whitish, annual, effused in irregular patches for as much as 30 centimeters, cracking or checking and becoming somewhat separable upon drying, coriaceous, mostly 2–3 mm. thick; margin white at first, tomentose, approximately 1 mm. wide, becoming fertile with age and appearing "cream buff" or "chamois"; subiculum whitish, mostly less than 0.3 mm. and inconspicuous, often disappearing in old plants; tubes 2–3 mm. long, mostly 2.5–3 mm.; mouths 2–3 to a mm., mostly 3, edges thick, white at first and remaining whitish in herbarium material or turning to "chamois" or "honey yellow" upon drying, appearing somewhat chalky but not rubbing off, spores smooth, hyaline, allantoid, 3.5–4 × 1 μ; hyphae hyaline, 2–4, mostly 3–4 μ, in diameter.

Allied species.—Among the porias *Poria quercuum* might suggest macroscopically weathered and old specimens of *P. xantha crassa*. The spores are approximately the same in size. Although *P. xantha crassa* occurs chiefly on conifers, it has been collected on hardwoods. *P. quercuum* is known only on broad-leaved species. It is not so chalky in texture and does not rub off between the fingers, as does *P. xantha crassa*. The pores of *P. quercuum* are much larger, 2–3 to a mm., whereas those of *P. xantha crassa* average about 5 to a mm.

Poria quercuum bears some resemblance to *Trametes serialis* and *T. sepium* because of its coriaceous nature and size of tubes and pore mouths. The smaller spores of *P. quercuum*, 3.5–4 × 1 μ, will distinguish it from these plants. Spores of *T. serialis* are 7–9 × 2–3 μ, and those of *T. sepium* are 8–14 × 3.5 μ. *T. Morgani* Lloyd, which is also in this group, is interpreted variously, but regardless of the name used all the plants in this complex have much larger spores than *P. quercuum*. Among them is *T. Trogii* Berk., which has spores that measure 8–10 × 2.5–3 μ. This plant, as interpreted by Overholts, and *T. Morgani* are synonymous.

Poria quercuum may look like weathered specimens of *Poria unita* and may suggest this species macroscopically. Furthermore, oak is a common subtratum for *P. unita*. These two polypores may readily be separated by spore measurements. The spores of *P. unita* are oblong-ellipsoid to oval or subglobose, whereas those of *P. quercuum* are allantoid, 3.5–4 × 1 μ.

Cultures. — Isolated from *Quercus stellata* from Branson, Missouri. Young cultures of *Poria quercuum* are snow white and cottony in texture. Growth of this rapidly growing fungus is equally fast at 25° C. and 30° C. (filling the petri dish at these temperatures within 7 days). Furthermore, the rate of growth is only slightly reduced at 35° C. (approximately 19.4 mm. in 7 days and 39.5 mm. in 14 days).

Poria quercuum develops on both red-gum and white-pine blocks in culture.

Habitat. — *Quercus stellata* and probably other native oaks of the south-central United States and the Southwest.

Distribution. — Missouri, probably Arkansas, Oklahoma, and the southwestern sections of the United States.

Decay. — A white indeterminate rot with wefts of whitish mycelium appearing in the checks of the subtratum.

Poria crustulina xerophytica var. nov.

(Plate II)

Type:

Poria crustulina xerophytica var. nov. on *Torreya californica*, July 25, 1938. Dow V. Baxter. Herb. Dow V. Baxter, Ann Arbor.

Fructificatio albida, annua vel raro perennis, longe effusa, longitudine usque ad 15 cm.; margine saepe conspicuo, 1–2 mm. lato, tomentoso, sterili, albide ochraceo, vel pallide salmonicolori plerumque siccitate

rubide ochraceo; tubis unistratosis, raro bistratosis, longitudine usque ad 3 mm., plerumque 2 mm., cum oribus concoloribus; oribus albidis vel pallide ochraceis vel ochraceis, siccitate plerumque pallide ochraceo-salmonicoloribus vel rufis, 0.3–0.5 mm. diam., plerumque 0.5 mm., dissepimentis crassis; basidiis 4–sporis; sporis 3–3.5 μ diam., 6.5–7 μ longis; hyphis hymenii 1–4 μ, plerumque 1–3, saepe incrustatis; cystidiis nullis. In truncis *Torreyae californicae* prope silvas "Muir Woods" dictas, in vicinitate San Francisco, California, Jul. 5, 1938; legit Dow V. Baxter.

Fructification whitish, annual or rarely perennial, effused in patches up to 15 cm. long; margin often conspicuous, 1–2 mm. wide, tomentose, sterile, whitish "cartridge buff," pale "pinkish buff," drying mostly "pinkish buff"; tubes in one layer, rarely in two, up to 3 mm. long, mostly about 2, concolorous with the mouths; mouths whitish "light buff" to "capucine buff," drying chiefly to "light ochraceous salmon" to "tawny," 2–3 to a mm., mostly 2 to a mm., dissepiments thick; basidia 4-spored; spores 3–3.5 × 6.5–7 μ; hyphae of the trama 1–4 μ, mostly 1–3, often incrusted; no cystidia. On *Torreya californica,* vicinity of Muir Woods, near San Francisco, California, July 5, 1938.

Allied species. — *Poria crustulina xerophytica* is intermediate in macroscopic appearance between *P. crustulina* and *P. subfusco-flavida,* but microscopically it is related more closely to *P. crustulina.* It may be distinguished from *P. subfusco-flavida* by the larger mouths and the somewhat larger spores. Its spores are described as being 3–3.5 × 6.5–7 μ, whereas those of *P. subfusco-flavida* are narrower, being (1.5) 2–2.5 × 4.5–7 μ.

The more distinctly allantoid spores of *Poria crustulina* and their slightly smaller width will serve to distinguish the species from variety *P. crustulina xerophytica.* Spores of *P. crustulina* are 2–3 × 5.5–7 (8) μ. *P. crustulina* is usually a thicker plant that covers wide surfaces of the substratum much as does *P. subacida* and checks or cracks upon drying. *P. crustulina xerophytica,* being thinner, does not crack open upon drying. It is more faintly pinkish, "light ochraceous salmon," and less "cinnamon buff" than the species *P. crustulina.* Both plants are on coniferous wood; *P. crustulina* attacks species of Pinaceae, whereas *P. crustulina xerophytica* is known only on the California nutmeg in the Taxaceae, namely, *Torreya californica.*

Poria Cocos (Schw.) Wolf, Journ. Elisha Mitch. Sci. Soc., 38 : 127–137. 1922

(Plates III–IV)

Lycoperdon solidum Clayton, Fl. Virg., p. 176. 1762.[3]
Lycoperdon cervinum Walt., Fl. Carol., p. 262. 1788.
Sclerotium giganteum MacBride, Trans. N. Y. Philosoph. Soc. 1817.
Sclerotium Cocos Schw., Syn. Fung. Carol. Super., pp. 30–31. 1822.
Pachyma Cocos (Schw.) Fries, Syst. Myc., 2 : 242–243. 1823.
Pachyma solidum Oken, Lehrbuch d. Naturg., 2ter Teil, Botanik. 1925.
Lentinus Tuber regium Fries, Epic. Syst. Myc., p. 392. 1836.
Pachyma pinetorum Horaninow, pp. 2–23. 1856.
Pachyma coniferarum Horaninow. 1856.
Tuckhaus rugosus Rafinesque, Med. Fl. N. Am., 2 : 255. 1830.

Type and important specimens examined:

Poria Cocos on corn and pine. Coll. F. A. Wolf, det. F. A. Wolf. U. S. Dept. Agric. Pathological and Mycological Collections, Beltsville, Md.

Fructification[4] appearing on a sclerotium; the sclerotia varying considerably in size and shape, frequently resembling a potato, but often much longer and larger, sometimes weighing as much as 10,000 grams ($22\frac{3}{4}$ lb.), easily cut with a knife when fresh, but drying extremely hard; interior becoming cracked, but the fissuring not perceptible from the exterior, cortex roughened and having the color of pine roots, the appearance suggested best in specimens in which flakes of bark constitute a part of the sclerotial context, the cortex consisting of densely compacted fungus cells making a well-defined layer 100–150 μ in thickness, interior whitish or tinged with pink when fresh, drying gray; fructification white and cartilaginous at first, becoming slightly brown and papery upon drying; margin fertile; tubes 2–3 mm. long; mouths large, angular, sinuous; basidia blunt, 20–30 × 6–8 μ, 4-spored; spores cylindric, smooth, 7–8 × 3.5 μ. Obovate conidiospores, 3–4 × 5–6 μ, have been reported on the surface of a sclerotium (4).

Conditions for fructification. — Fructification upon the sclerotium is apparently conditional upon at least three factors: (*a*) fresh sclerotia; (*b*) saturation with water, and (*c*) the presence of light (32). If the sclerotium has not dried out, the fungus can be made to fruit within a few days by placing in a moist chamber parts of the sclerotium which have been soaked in water.

[3] The list of synonyms has been reported by Weber (30).
[4] The description presented here is based largely upon that of Wolf (32, 33).

Habitat. — *Abies balsamea, Betula lutea, Citrus paradisi,*[5] *C. sinensis,*[5] *Carya sp.,*[6] *Erythrina herbacea, Eucalyptus sp.,*[5] *Fagus grandifolia, Juniperus virginiana, Magnolia grandiflora,*[5] *Pinus caribaea, P. echinata, P. rigida,*[7] *P. taeda,*[7] *Prunus serotina, Quercus alba,*[8] *Q. borealis maxima,*[8] *Q. coccinea,*[8] *Q. montana,*[8] *Q. phellos,*[5] *Q. velutina,*[8] *Rhus sp., Taxodium distichum, Tsuga canadensis, Zea Mays.*

Distribution. — Manitoba, Saskatchewan, Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Kansas, Kentucky, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Wisconsin.

Occurrence. — The tuckahoes occur largely in sandy soil and may be slightly covered with sand or actually buried several feet deep, according to Weber (30).

Gore (14) also reports them as occurring in light sandy soil or sandy loam that is not too wet, and they likewise occur in old fields or woodlands. Güssow (15) found the Canadian tuckahoe in poplar woods. They occurred eighteen inches deep in yellow ferruginous sand encircling an oak-tree root, according to Lockwood (22). Wolf (32) believes that the tuckahoes are generally attached to tree roots growing in sandy soils, in flat woods, hammock and grove lands of North Carolina. They are buried in sand in depths down to two feet (30). The occurrence of sclerotia on "little-leaf" diseased trees (*Pinus echinata*) has been recorded by Jackson (19). He frequently found sclerotia on little-leaf trees but not on healthy pine.

Common names. — Weber (30) has given so excellent a history of the common names applied to *Poria Cocos* (Schw.) Wolf that the material presented here is based largely upon his account. The earliest records concerning tuckahoes, according to this author, appeared in 1722 in a history of the State of Virginia, in which there are accounts relating to the tuckahoes that the Indians dug out of the ground. An earlier reference to tuckahoes, however, was located in a rare copy of a 1705 edition of the history and present state of Virginia which is in the William L. Clements Library of the University of Michigan (see Plate IV). The term "tuckahoe" is a common one for a certain type of sclerotium. It has also been used to describe various kinds

[5] Reported in Weber (30).
[6] Reported by Murrill (25).
[7] Reported by Wolf (32).
[8] Reported by Davidson, Campbell, and Vaughn (10).

of tuberous roots, as is indicated in this early reference, and Indians had similar terms to designate the tuberous roots collectively. "Tuckahoe," "tawkee," "ptucaui," "petukqui," and "pittikmow" were in common use (14, 30). Weber (30) reports that Peter Kahm, in his *Travels in North America,* published in 1772, listed the words "tawko," "tawking," "tuckah," "tawkee," "tawkin," "tockim," and "tockin" as names of more or less bulbous edible roots. It appears that the names mentioned include all tuber-like plants, whether they were of phanerogamic or cryptogamic origin. The present account has to do only with the fungus sclerotium designated by the binomial *Pachyma Cocos* (Schw.) Fries, by which the plant was known for almost a hundred years, or *Poria Cocos* (Schw.) Wolf, the name now correctly applied to it.

Cultures. — Isolated from oak by Davidson, Campbell, and Vaughn (10), and from *Pinus echinata* by Jackson (19). The reports here are based upon their data and upon the cultures in the Laboratory of Pathology in Forest Practice obtained from the United States Division of Forest Pathology.

The growth is usually rapid, forming either a "cartridge-buff" or a "pale pinkish-buff" mat, oppressed-cottony at center to loose-cottony at margins; or oppressed, "army brown" to "Vandyke brown," margins often loose-cottony; when first isolated inclined to be oppressed, brown, but becoming loose-cottony. Lacerate-poroid, white resupinate fruiting surfaces forming in ten-day-old mats. According to Jackson (19), isolates from short-leaf pine show minor variations from those isolated from oak by Davidson and others. These characters, the formation of chlamydospore-like cells, the fragrance of mycelium on cooked wheat, and the dark-brown form of growth are regarded as differences in isolates.

The submerged and superficial hyphae are 2–15 μ in diameter, thin-walled, prominent septations, often constricted and without clamp connections, breaking up into short irregular lengths with interspersed empty cells; irregular inflated cells either single or in chains; basidiospores cylindric, 7–9 × 3–4 μ, viable.

Optimum temperature for growth is approximately 30° C. The most noticeable features of the fungus in culture, according to these investigators, are its fragile "pale pinkish-buff" mat; the exceptionally large septate, often much-constricted, hyphae; and the large connected, inflated cells. When the fungus fruits, the cylindric

basidiospores produced in coarse poroid or lacerate fruiting bodies are also distinctive.

The fungus gives a negative reaction to tannic-acid medium (9).

Pathogenicity. — *Poria Cocos* has been inoculated on the roots of shortleaf pine two and three years old and grown in pots of nonsterile soil by Jackson (19). The roots of the seedlings were so treated at the time of transplanting by scattering grains of cooked-wheat inoculum through the soil about one-half inch from the roots. Controls were inoculated with sterile cooked wheat.

All the isolates of *Poria Cocos* spread rapidly in the soil, and in some pots poroid mats formed on the surface of the soil in fourteen days. Heavy losses of pine trees were caused in a relatively short time. "For all isolates the number of plants killed in twelve to ninety days varied from 79 to 100 per cent per series."

Feeding roots of the affected pine trees were decayed. Bark on the inoculated trees became loose and dark brown. The stele was light brown. *Poria Cocos* was reisolated from the steles.

The pathogenicity of the fungus as demonstrated (19) confirms Wolf's assumption (32) that the fungus is probably parasitic. The addition of woods humus to the soil at the time of inoculation failed to affect the pathogenicity of the poria.

Economic importance and decay. — From the report of Banning (1) and the accounts studied by Weber (30), it appears that the sclerotia were at times used as food, being roasted and eaten by natives or, later, by Negroes who had learned from the Indians that they were edible. They were also employed in making a kind of bread. Some records indicate that they were not eaten raw because they were poisonous. Fries (12) reported that they contained certain medicinal properties and were used by the natives in remedies. Rafinesque (27) believed that tuckahoes were the most delicate of all food, being odorless and having a fine taste. On the other hand, Murrill (24) did not think that they were a common source of food or that the sclerotia had any curative properties.

Poria Cocos has been isolated from decayed black cherry trees by Davidson and Campbell (8). These authors obtained cultures of the fungus six times from butt sections of *Prunus serotina*. The fungus is also reported as a cause of heartrot in oak. It might be assumed further that the fungus causes decay as a saprophyte, since it has been reported on railroad ties in service (4).

Sclerotia have invariably been found among the roots of pine trees, *Pinus taeda* and *P. rigida,* by Wolf (32), but the exact relationship of the fungus to these trees has not yet been determined.

Polyporus balsameus Peck, Ann. Rep. New York State Mus., 30 : 46. 1878

(Plate V)

Polyporus apalus Léveille (teste Pilát), Ann. Sci. Nat., p. 124. 1843.
Polyporus crispellus Pk., Ann. Rep. New York State Mus., 38 : 91. 1885.
Coriolus balsameus (Pk.) Murr., N. Am. Fl., Pt. I, p. 21. 1907.
Coriolus kymatodes (Rostk.) B. & G. (teste Pilát), Bull. Soc. Myc. de France, 41 : 143. 1925.
Coriolus apalus (Lév.) B. & G. (teste Pilát), H. de Fr., 566. 1928.
Tyromyces crispellus (Pk.) Murr., N. Am. Fl., 9 : 34. 1907.
Tyromyces balsameus (Pk.) Murr., Myc., 12 : 7. 1920.
Tyromyces kymatodes (Rostk.) Donk (teste Pilát), Med. Bot. Mus. Utrecht, 9 : 153. 1933.
Leptoporus almaatensis Pilát (teste Pilát), Bull. Soc. Myc. de France, 52 : 307, t. 3, f. 1–2. 1936.
Leptoporus kymatodes (Rostk.) Pilát, Atlas des Champignons de l'Europe, III. 214. 1936.

Fructification sessile, effused-reflexed, resupinate, or appearing substipitate, corky when fresh, rather rigid in dried specimens, 1–3 × 2–5 × 0.2–0.5 cm. (Lowe), surface whitish to pale brown, drying "light buff," markedly villose to tomentose, with lighter concentric zones, occasionally becoming reddish ("benzo brown") when bruised; margin thin; context white, 1–4 mm. thick; tubes white, 1–3.5 mm. long; mouths white, 2–6, mostly 4–5, to a mm.; edges thin, dentate; spores hyaline, smooth, frequently one-guttulate, ellipsoid to ovoid, 3–5 × 2–3 μ; hyphae seldom branched, 5–9 μ in diameter; cystidia thin-walled, not incrusted, 4–9 μ in diameter and projecting up to 20 μ.

Allied species. — *Polyporus floriformis* Quél. and *Pol. tephroleucus* Fr. have been reported as synonyms by Hubert (16), but are not so regarded in the present study. Cystidia are not present in *Pol. floriformis.* The spores of *Pol. tephroleucus* are allantoid, 4–5 × 0.7–1.5 μ (Overh.), in contrast to the ovoid spores of *Pol. balsameus,* which measure 3–5 × 2–3 μ.

Habitat. — *Abies balsamea, Betula lutea, Picea glauca, P. rubra, P. sitchensis, Pinus Strobus, Prunus serotina, Thuja occidentalis, T. plicata, Tsuga canadensis.*

Distribution. — British Columbia, Nova Scotia, New Brunswick, Ontario; Newfoundland; California, Maine, Michigan, Minnesota, New Hampshire, New York, Oregon, Pennsylvania, Tennessee, Washington, Wisconsin.

Occurrence. — Although the fungus appears in the West Coast states, it is found chiefly from Minnesota eastward, through eastern Canada, and in New England. I have never discovered it on any of the western species of Abies. *Polyporus balsameus* is usually associated with decay in balsam fir and other conifers, but has been collected on yellow birch and black cherry on the Allegheny National Forest (8).

Decay. — *Polyporus balsameus* produces a brown cubical rot similar to that caused by *Pol. Schweinitzii.* In the early stages of decay infected areas become buff or buff yellow. Later the wood darkens to a clay color or a chocolate brown. Shrinkage cracks appear, and the attached wood breaks up into large cubes (3). A thin powder-like layer of mycelium often forms within the shrinkage cracks.

Signs of rot. — The fruiting bodies are in evidence for only a short period, and they usually occur on trees growing on moist sites. They may be found on the trunk at the base of limbs, but they are more commonly attached to exposed roots in the root crotches and basal scars. In nature insects soon destroy the fruiting bodies. Basal scars, fire scars, and frost cracks are usually observed in connection with trees showing this rot. Resin flow in the root crotches and along the exposed parts of roots often accompanies decay (16, 17).

Cultures. — Isolated from heartwood of *Abies balsameus* and sporophore tissues by Clara W. Fritz. Initial growth consists of delicate colorless hyphae, which bear numerous clamp connections. Within a week chlamydospores with thick, smooth hyaline walls form in terminal or intercalary positions and, according to Fritz (13), they produce conidium-like sprays in the first type and long beadlike chains in the latter. These chlamydospores measure 7–10 × 12–22 μ. The fungus mats are at first thin, downy-hairy, with a broad, straggling, colorless appressed margin, becoming close-woolly and finally assuming a spongy texture over the surface. The fungus is white and gradually changes to "cream buff" and "cinnamon buff" to even drab in culture. *Polyporus balsameus* gives a negative reaction to tannic-acid medium.

Importance. — Butt rot in balsam due to *Polyporus balsameus* is secondary in importance to *Poria subacida,* but it contributes greatly

to the rapid deterioration of balsam-fir stands killed by *Harmologa fumiferana* Clem., the spruce budworm (5).

Kaufert (20) reports that of 690 trees examined in the Lake States 70 per cent had butt rot alone and that 23 per cent had both butt and top rot. These studies were made in Minnesota and Wisconsin, and included sample areas on the Chippewa and Chequamegon national forests and on lands of the Northwest Paper Company and of the Minnesota and Ontario Paper Company. It might appear that the greatest amount of cull losses was caused by butt rot. Analysis of the data showed, however, that decay in all the trees amounted to 16.5 per cent of growth. Since the net increment is still appreciable on trees ninety years old, stands of that volume could probably be left. Of this volume 8.7 per cent was due to butt rot and 7.8 per cent to top rot. Although butt rot appeared in a far greater number of trees than top rot, apparently it did not cause as much cull. This result is due partly to the fact that butt rot is confined to the lower part of the bole, whereas top rot usually occupies a high percentage of the upper and merchantable part of the trunk.

Of the 642 trees with butt rot 471, or 73.4 per cent, had yellow stringy rot (caused by *Poria subacida*) and 110, or 17.1 per cent, had brown cubical rot. When estimates are made on a volume basis, *Polyporus balsameus* caused 5.7 per cent of the losses, and *Poria subacida* caused 89 per cent. Hubert (16) states that in Door County, Wisconsin, most of the balsam firs ranging in diameter from three to eighteen inches were found to be infected with *Pol. balsameus*. In badly rotted trees the rot column extended from six to twelve feet up in the trunk. Wind and snow breakage is common in many areas where the balsam are badly decayed.

Butt rot examined by Kaufert in balsam fir up to 60 years of age was of minor importance. In trees 60 to 150 years old it gradually increased until at 150 years it covered 41 per cent of the total volume of the tree. Considering the percentage of trees infected with butt rot, the percentage of decay, and the percentage of cull for the various age classes, it was determined that the net periodic increment in the tree is greatest at about 70 years, after which it decreases gradually until at approximately 100 years decay and cull offset age without severe decay losses. Kaufert reports, however,

that after 80 years damage from wind breakage would be considerable.

Balsam fir usually grows in uneven-aged stands in mixtures with other species, so that diameter relationships to decay incidence are of importance. Age determinations are costly to make in such forests. Kaufert finds that the percentages of rot and the percentages of cull increase with increase in diameter. The highest periodic increment is reached, however, at a diameter between 9 and 10 inches. The age of 9- or 10-inch balsam examined is about 90 years.

Polyporus balsameus in the interior of British Columbia was reported by Buckland (6) as being responsible for but little of the brown cubical rot that occurs in western red cedar. He points out, however, that some of the butt-decay infections attributed to other fungi may have been due to *Pol. balsameus* and adds that additional study may indicate a greater relative importance of the fungus as a cause for brown cubical rot in this tree.

Poria aurea Peck, 43d Rep. New York State Mus., p. 21. 1890

Type and important specimens examined:

Poria aurea on *Acer saccharinum* (other specimens on same sheet as type on conifers), Sevey, New York Herb. New York State Museum, Albany, New York.

Poria aurea Pk., Coll. G. F. Atkinson, Port Jefferson, Long Island, New York. 1904. Identification confirmed by Dr. Chas. Peck. Herb. G. F. Atkinson, Ithaca, New York.

Fructification annual, effused up to separable when fresh (Peck), watery as in *Poria subacida* when fresh; margin byssoid, greenish yellow (Peck) in fresh growing plants; subiculum thin, "subgelatinous," drying somewhat translucent, inconspicuous; tubes 2–5 mm. long, concolorous with the mouths; mouths golden yellow when fresh, 2.5–5 to a mm.; spores oblong or short-cylindric, smooth, hyaline, 5.5–7.5 × 2.5–3.5 μ (Overh.); cystidia abundant, conspicuous, 30–50 × 12–20 μ (Overh.); hyphae branched, thin-walled, 2–3 μ in diameter, clamp connections present.

Allied species.—*Poria aurea* is most closely allied to *P. subacida* and may readily be confused with that species in the field, particularly in the West. The present appearance of the Peck specimen is much like that of a thin, watery *P. subacida*. Overholts (26) observed this and reported that it differs from *P. subacida*, "as it does from all other known species, in the well-developed, mainly unincrusted cystidia."

Colors, as well as the presence of unincrusted cystidia, are confusing, however, in the description of *Poria colorea* Overholts and Englerth as presented by Englerth (11). He stated that the sporophores of the yellow rot fungus "resemble those of *P. subacida* closely," but that "the sporophores of *P. subacida* are white when fresh, turning buff when old, while those of *P. colorea* are antimony yellow to golden yellow in color." Nonincrusted cystidia are listed in the description as "16–20 × 5–7 μ" and as "seen occasionally." "The fungus should be referred to as *Poria colorea* Overholts and Englerth." In the description of *P. aurea* the pore surface is golden yellow, *fide* Peck.

Since the points of difference of *Poria colorea* and *P. subacida* do not seem significant, in this series *P. colorea* is not recognized as a species. The spore measurements of *P. colorea* are given for the Overholts and Englerth plant as broadly ellipsoid, 4–5–6 μ × 3.5–4 μ, whereas Overholts gives the spores of *P. aurea* as oblong or short-cylindric, 5.5–7 × 2.5–3.5 μ.

Habitat.—*Acer saccharinum, Picea sitchensis, Tsuga heterophylla.*
Distribution.—Alaska, Oregon, New York.

Polyporus adustus (Willd.) Fr., Syst. Myc., 1:363. 1821

(Plate VI)

Leptoporus adustus (Willd.) ex Fr., Quél., Ench. Fung., 177. 1886.
Boletus adustus Willd., Fl. Berol. Prod., p. 392. 1787.
Boletus fuscoporus Planer, Ind. Pl. Erf., p. 26. 1788.
Boletus suberosus flabelliformis Batsch., Elench. Fung. Contin., 2:117, pl. 226. 1789.
Boletus carpineus Sow., Eur. Fl., 2:t. 231. 1799.
Polyporus carpineus (Sow.) Secretan (teste Pilát), Mycographie suisse, 3:123. 1833.
Polyporus crispus (Pers.) Fr., Syst. Myc., 1:363. 1821.
Polyporus pallescens Fr., Syst. Myc., 1:369. 1821.
Boletus isabellinus Schw., Schr. Nat. Ges. Leipzig, 1:96. 1822.
Polyporus subcinereus Berk., Ann. Mag. Nat. Hist., II, 3:391. 1839.
Polyporus demissus Berk. (teste Pilát), Hook. Journ. Bot., 4:52. 1845.
Polyporus Halesiae Berk. & Curt., Ann. Mag. Nat. Hist., II, 12:434. 1853.
Polyporus adustus carpineus (Sow.) Fr., Hymen. Europ., 550. 1874.
Polyporus caerulus Fr. (teste Pilát), Hymen. Europ., 549. 1874.
Polyporus tristis Fr. (teste Pilát), Hymen. Europ., 581. 1874.
Polyporus dissitus Berk. & Br. (teste Pilát), Journ. Linn. Soc., 14:48. 1875.
Polyporus Lindheimeri Berk. & Curt., Grevillea, 1:50. 1892.
Bjerkandera adusta (Willd.) Karst., Meddel. Soc. Faun. Fl. Fenn., 5:38. 1879. In part.
Polyporus Mac-Owani, Kalch. (teste Pilát), Grevillea, 10:54. 1880.
Polyporus simulans Karst. ex Lloyd, Synopsis of the Section Apus of the Genus Polyporus, p. 386. 1915.

Myriadoporus adustus (Willd.) Peck, Bull. Torr. Bot. Club, 11:27. 1884.
Polystictus similans (Berk. & Curt.) Sacc. (teste Pilát), Syll. Fung., 6:117. 1888.
Polyporus Burtili Peck, Bull. Torr. Bot. Club, 24:146. 1897.
Coriolus alabamensis Murr., N. Am. Fl., 9:19. 1907.
Polystictus adustus (Willd.) Big. & Guill. (teste Pilát), 2:371, t. 27, f. 3. 1913.
Polystictus adustus var. *crispus* (Pers.) Big. & Guill. (teste Pilát), 2:372. 1913.
Polystictus carpineus (Sow.) Konrad, Bull. Soc. Myc. Fr., 39:14. 1923.
Gloeoporus adustus (Willd.) Pilát, Atlas des Champignons de l'Europe, 157. 1936.

Fructification sessile, effused, reflexed-imbricate, often confluent, 1–5 × 2–9 × 0.1–0.8 cm., or often resupinate and occasionally extending over a long surface for two or three meters or more, corky; surface white or gray to "light pinkish cinnamon," finely tomentose, azonate or indistinctly zonate, margin thin, sterile below, often becoming blackish; context white or "light buff," 1–6 mm. thick, hyphae in radial arrangement; tubes at first whitish then gray to black, 0.5–3 mm. in length; mouths concolorous with the tubes, 5–8 to a mm., round to angular; basidia 4-spored, 4–5 × 9–14 μ in diameter; spores hyaline, smooth-cylindric to cylindric-ellipsoid, seldom allantoid (curved), 3–5 × 1.5–2.5 μ; hyphae rarely branched, thick-walled, 4–6 μ in diameter; cystidia none.

Allied species.—The nearest allied polypore to *Polyporus adustus* is *Pol. fumosus*. The differences between the two plants are mostly relative. The mouths of *Pol. adustus* are somewhat smaller, i.e. 5–8 to a mm., whereas in most specimens of *Pol. fumosus* they are 3–5 to a mm. The tubes may be longer than those recorded for *Pol. adustus*, and the fruiting body itself is thicker. It is known that *Pol. adustus* has deep smoke-colored pores when growing, whereas *Pol. fumosus* has white pores that turn smoky in drying. *Pol. crispus* (Pers.) Fr., which is regarded by many as a good species but which is here classed as a synonym of *Pol. adustus*, is said to differ from the latter only in the radially appressed fibrils on the surface of the pileus and the crisped or wavy margin of the pileus (29).

A few specimens of this plant have been collected on conifers. These are so thin and possess such a stereum-like margin that *Polyporus pallescens* Karst. is suggested. That species, however, does not possess dark-colored tubes.

It is usual for specimens entirely resupinate to separate at the margin upon drying, so that one can distinguish this polypore from a true poria. In Oklahoma and elsewhere in the Southwest, however, the plant may become and remain entirely resupinate, so that an

abundance of material in various stages of growth is necessary before an accurate diagnosis can be made. *Polyporus adustus* is more likely to occur in the resupinate stage in the Plains states than farther east.

Habitat. — *Abies balsamea, Acer Negundo, A. rubrum, A. saccharinum, A. saccharum, Aesculus californica, Alnus oblongifolia, A. rubra, Betula lutea, B. neo-alaskana, B. papyrifera, B. papyrifera occidentalis, Carpinus caroliniana, Celtis sp., Cercis canadensis, Citrus sp., Cornus florida, Eucalyptus globulus, Fagus grandifolia, Gleditsia sp., Halesia carolina, Hicoria ovata, Ilex opaca, Juniperus virginiana, Larix occidentalis, Liquidambar Styraciflua, Liriodendron tulipifera, Magnolia virginiana, Nyssa sylvatica, Ostrya virginiana, Picea excelsa, P. rubra, Pinus ponderosa, P. Strobus, Platanus occidentalis, Populus balsamifera, P. deltoides, P. grandidentata, P. tremuloides, P. trichocarpa, Pseudotsuga taxifolia, Prunus demissa, P. pennsylvanica, P. serotina, Quercus alba, Q. borealis maxima, Q. Garryana, Q. velutina, Rhus taxicodendrum, Robinia pseudoacacia, Rubus sp., Salix alba vitellina, S. nigra, Syringa vulgaris, Thuja occidentalis, T. plicata, Tilia glabra, Ulmus americana, Viburnum Sargenti, Vitus sp.*

Distribution. — Alberta, British Columbia, New Brunswick, Manitoba, Nova Scotia, Ontario, Quebec, Saskatchewan; Alaska; Alabama, Arizona, Arkansas, California, Colorado, Connecticut, District of Columbia, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming.

Occurrence. — The fungus is known not only over much of North America and Europe, but also in such widely separated places as Cuba, the Argentine Republic, Patagonia, and the Philippines. In Australia it has been reported from New South Wales and Queensland (28). In the United States it is less prevalent in the areas west of the one hundredth meridian.

Polyporus adustus attacks over thirty different genera of trees. It is most common on hardwoods, especially species of Populus, throughout the continent. It occurs occasionally on conifers. *Abies balsamea, Pinus ponderosa, Larix occidentalis, Thuja plicata,* and

Pseudotsuga taxifolia are reported America substrata; it is known on *Picea excelsa* in Sweden (31). The fruiting bodies are usually somewhat thinner than those that appear on hardwood timber and at times are almost "stereum-like." It causes decay in standing hardwoods injured by fire.

Cultures.—*Polyporus adustus,* one of the most common of the polypores, has not been studied extensively in cultures by Americans; apparently it exhibits an optimum growth at 25° C. Cartwright and Findlay (7) report about 25° C. for the English isolate, and it is therefore placed in the Intermediate-Temperature Group of Humphrey and Siggers (18), that is, the optimum is between 24° and 32° C. Cartwright and Findlay also cultured the closely related *Pol. fumosus,* which make slightly less growth at various temperatures than *Pol. fumosus,* as is shown by results given in Table I. It produces a smooth soft white (or slightly yellowing on aging) cottony-woolly growth. The odor is faintly fragrant. A few swellings of the chlamydospore type are present, and clamp connections occur (7).

TABLE I

GROWTH OF POLYPORUS ADUSTUS AND POL. FUMOSUS COMPARED

Species	Temperature in centigrade					
	15°	20°	25°	27°	30°	35°
Pol. adustus	2.8	7.9	8.0	7.8	3.5	0
Pol. fumosus	2.5	5.1	7.4	6.4	1.5	0

The fungus gives a positive reaction to tannic-acid medium.

Decay. — *Polyporus adustus* brings about a white, mottled aspect, which often extends into the heartwood of a tree or a log. The infected wood gradually becomes lighter in color and weight than that which is sound. White areas appear to run radially throughout the wood during the early period of decay and become more conspicuous as fungus activity progresses. No black lines or zones are formed.

Development of saprot caused by this fungus in red gum has been described by von Schrenk (28) with reference to logging and milling practices. Where red gum is felled for its lumber the logs are sawed in the woods and are skidded to the bank of a stream for either floating or rafting later on, or hauled by truck or railroad to the mill. Less decay takes place in logs that are hauled to the mill and sawed at

once. The boards dry out in the piles "to such an extent that the growth of the fungus is made impossible." If, however, the logs are rafted, saprot will result in from one to several weeks after the timber has been cut, depending upon the season of the year. Green red-gum logs sink when placed in water, so that it is customary to pile them along stream banks for some months until they have dried out to such a degree that they can be rafted by the aid of cottonwood or other lighter logs. Rafting or floating takes place during December and January, when a sufficient amount of water is available. Summer-cut logs manufactured into boards show decay, which may extend from both ends of the log throughout the sapwood for distances ranging from several inches to several feet.

Freshly sawed boards that are infected with *Polyporus adustus* are characterized by streaks of various colors. These streaks are light orange in the region of first change. When the wood has decayed further, affected areas become straw-colored or whitish. It is only after the fungus has grown into the wood for a considerable distance (two or three feet), however, that a marked disintegration results.

According to von Schrenk, it is not unusual to find more than 75 per cent of freshly sawed boards in one pile forming fruiting bodies within two weeks after the planks are piled in stacks.

Prevention of Decay.—Saprot in red gum caused by *Polyporus adustus* may be prevented by shortening the drying period in the woods, either by hauling the logs by truck or rail or by reducing the moisture in the log. Von Schrenk (28) finds that the drying may be accomplished by leaving the felled gum trees in the forest and postponing the sawing until the leaves are thoroughly dry. The amount of water evaporated by the leaves may be sufficient to permit floating the logs.

Saprot may likewise be retarded by end coatings of the logs. Wherever possible, freshly cut logs, especially those that are cut during spring and summer months, should be peeled.

Polyporus biformis (Klotsch) Berk., Linnaea, 8 : 486. 1833

(Plate VII)

Polyporus molliusculus Berk., Lond. Journ. Bot., 6 : 320. 1847.
Polyporus carolinensis Berk. (ex Murrill), Journ. Bot. and Kew Misc., 1 : 102. 1849.
Polyporus chartaceus Berk. (ex Murrill), Journ. Bot. and Kew Misc., 1 : 103. 1849. Grevillea, 1 : 53. 1872.

Polyporus scarrosus B. & C. (ex Murrill), Grevillea, 1:52. 1872.
Polyporus pallidocervinus ex Lloyd, Synopsis of the Section Apus of the Genus Polyporus, p. 383. 1915.
Polystictus biformis (Fr.) Sacc., Syll. Fung., 6:240. 1888.
Coriolus biformis (Klotzsch) Pat., Tax. Hymen., p. 94. 1900.

Fructification sessile, effused-reflexed or resupinate; pileus whitish, drying alutaceous-coriaceous or often rigid when dry, 1–5 × 1–6 × 0.2–1.2 cm. or resupinate; surface whitish to "pinkish buff," "cinnamon buff," "Sayal brown," with radiating fibrils; margin thin; context white, 1–6 mm. thick; tubes white or whitish, mostly 2–6 mm. long; mouths white to yellowish or light brown, i.e. white to "cinnamon buff," sometimes drying to "cinnamon brown," large, commonly breaking up to form teeth, 1–2 to a mm., no cystidia, spores hyaline, smooth-cylindrical, 6–8 × 2–2.5 μ, hyphae 3–4 μ in diameter.

Allied species. — *Polyporus biformis* is closely allied to *Pol. pubescens*. *Pol. biformis* differs from *Pol. pubescens* in that the mouths in *Pol. biformis* are large (1–2 to a mm.), whereas in *Pol. pubescens* they are smaller, i.e. 3–4 to a mm.

Habitat. — *Acer rubrum, A. saccharum, Alnus tenuifolia, Arbutus Menziesii, Betula lenta, B. lutea, B. neo-alaskana, B. papyrifera, Carpinus sp., Fagus grandifolia, Fomes fomentarius* (fruiting body), *Fraxinus nigra, Hicoria cordiformis, H. glabra, Juglans cinerea, Liquidambar Styraciflua, Liriodendron Tulipifera, Lithocarpus densiflora, Nyssa sp., Picea mariana, Populus grandidentata, Prunus pennsylvanica, Quercus alba, Q. borealis maxima, Q. Emoryi, Q. Garryana, Q. marilandica, Q. rubra, Q. texana, Q. velutina, Q. virginiana, Robinia pseudoacacia, Salix sp., Tilia sp., Ulmus americana, Umbellularia californica.*

Distribution. — British Columbia, Manitoba, Nova Scotia, Ontario, Quebec; Northwest Territories, Yukon Territory; Alaska; Alabama, Arkansas, California, Connecticut, Delaware, District of Columbia, Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin.

Occurrence. — This common plant in America occurs rather infrequently in Europe. Lloyd (21) points out that *Polyporus biformis* grows in Cuba (but is there called *Polyporus pallidocervinus*) and that it is the same as the ubiquitous American species. It is rare in Africa.

I have found *Polyporus biformis* more abundant in Ozark County, Arkansas, than elsewhere in the United States.

Poria ferox Long & Baxter, Pap. Mich. Acad. Sci., Arts, and Letters, 25 (1939) : 149. 1940

(Plates VIII–IX)

Baxter, *op. cit.* Sections pertaining to description, allied species, distribution, and decay are presented.

Cultures.—Isolated from *Juniperus virginiana* from Mountain View, Arkansas. Young cultures of *Poria ferox* are snow white and cottony in texture. The best growth of the rapidly growing fungus, as shown by the average of six tests, takes place at approximately 30° C. (19.4 mm. in 7 days and 36.8 mm. in 14 days). The plant develops almost equally well, however, at 25° C. (15.0 mm. in 7 days and 36.2 mm. in 14 days). Growth at 35° C. is rapid compared to that of a large number of resupinate polypores (12.6 mm. in 7 days and 30.0 mm. in 14 days).

This fungus, which attacks coniferous standing trees in nature, may be cultured on both coniferous and frondose woods. The mycelium, however, grows somewhat more profusely on red-gum than on white-pine test blocks.

Fomes Earlei (Murr.) Sacc. & D. Sacc., Sacc. Syll., 17:119. 1905

Pyropolyporus Earlei Murr., Bull. Torr. Bot. Club, 30:116. 1903.

Fructification undulate, woody, attached by a broad base, approximately 6 × 13 × 17 cm., surface concentrically sulcate, very rimose, "olive brown" or "clove brown," at length grayish black; margin broad, obtuse, brown "cinnamon buff" to "clay color," tomentose; context woody, brick red, "cinnamon rufous" to "kaiser brown"; concentrically banded with darker lines, only approximately 0.5 cm.; tubes unevenly stratified, 0.5–0.75 cm. long each season, mouths yellowish brown, "chamois" to "Sayal brown"; 1–2 to a mm.; circular; spores ellipsoid, smooth, thick-walled, ferruginous 7–8 × 9 μ (Murr.).

Distribution.—Arkansas, New Mexico.

Habitat.—*Juniperus monosperma, J. sabinoides, J. utahensis, J. virginiana.*

Occurrence.—Murrill (23) reports that in 1908 the fungus was known

only from the type locality. Since then so many collections have been made in the Southwest that it is regarded primarily as a southwestern fungus. It is here reported on red cedar in the Arkansas National Forest areas near Mountain View. *Fomes Earlei* occurs on standing green timber only.

Cultures.—Isolated from standing *Juniperus virginiana,* Mountain View, Arkansas.

Fomes Earlei is characterized by its bright brown chamois skinlike mycelium, which is "primuline yellow," and commonly exhibits "claret brown" droplets on the surface.

The fungus is the slowest-growing polypore in the Michigan collection of cultures. Mycelium does not develop on the agar in petridish cultures at 25°, 30°, or 35° C. in 7-day tests, and the extent of its radial development averages only 2 mm. at 25° and 30° C. in a 14-day period. No growth occurred at 35° C.

This fungus, which attacks coniferous standing trees, may be cultured on both coniferous and frondose woods. The mycelium, however, grows somewhat more profusely on white-pine than on red-gum blocks.

Decay.—*Fomes Earlei* causes a "yellow rot," producing long tubelike holes in the heartwood.

Remarks.—The description is based upon that presented by Murrill. *Fomes Earlei* is not a resupinate polypore, but because of its relationship to other brown resupinate members of the Fomes and "Fomitipora" groups, it is included here.

Fomitoporella melleopora Murr., North Am. Flora, Pt. I, p. 13. 1907

Baxter, Dow V., Pap. Mich. Acad. Sci., Arts, and Letters, 18 (1946) : 191–212. 1948. Sections pertaining to description, allied species, habitat, distribution, and occurrence are presented.

Cultures.—Isolated from *Populus tremuloides,* Michigan National Forest, East Tawas, Michigan.

Poria melleopora is characterized by its varying appearance in culture at different temperatures. In two-week-old cultures at 25° C. the mycelium, unlike that of the majority of brown resupinates, is somewhat silky, white at the margins, and "aniline yellow" nearer the inoculum. In contrast, cultures kept at 30° C. are cottony in texture and uniformly "cartridge buff" to "cream buff" and more nearly

resemble other species of polypores — *Fomes Everhartii,* for example. The cultures grown at 25° C. suggest those of *Polyporus radiatus,* except that agar does not turn dark in these two-week-old tests of *Poria melleopora.* The cottony texture is retained in cultures kept at 35° C., but the color is lighter and generally whitish instead of light brown.

Poria melleopora grows more rapidly at 30° C. in 7- or 14-day-old cultures than at 25° C. or 35° C., but, unlike many of the resupinate forms, it exhibits a greater growth at 35° C. than at 25° C. at the end of either a 7- or a 14-day test.

This fungus, which attacks hardwoods in nature, may be cultured on both frondose and coniferous woods. The mycelium, however, grows only slightly more profuse on red-gum blocks than on white-pine test pieces.

University of Michigan

LITERATURE CITED

1. Banning, Mary E. 1882. The Tuckahoe. Bull. Torr. Bot. Club, 9: 125.
2. Baxter, Dow V. 1948. Some Resupinate Polypores from the Region of the Great Lakes. XVIII, 32 (1946): 191–212.
3. —— 1943. Pathology in Forest Practice, xi + 618. John Wiley & Sons, New York.
4. Berkeley, Earl E. 1934. Poria Cocos (Schw.) Wolf, Found on a Railroad Tie in Service. Ann. Mo. Bot. Garden, 21: 339–340.
5. Boyce, J. S. 1938. Forest Pathology, x + 600. McGraw-Hill Book Co., New York.
6. Buckland, D. C. 1946. Investigations of Decay in Western Red Cedar in British Columbia. Can. Journ. Res., C, 24: 158–181.
7. Cartwright, K. St. G., and Findlay, W. P. K. 1934. Studies in the Physiology of Wood-destroying Fungi. II. Ann. Bot., 48: 481–495.
8. Davidson, Ross W., and Campbell, W. A. 1943. Decay in Merchantable Black Cherry on the Allegheny National Forest. Phytopathology, 33: 965–985.
9. —— —— and Blaisdell, D. J. 1938. Differentiation of Wood-decaying Fungi by Their Reaction on Gallic or Tannic Acid Medium. Journ. Agric. Res., 57: 683–695.
10. —— —— —— and Vaughn, D. B. 1942. Fungi Causing Decay of Living Oaks in the Eastern United States and Their Cultural Identification. U. S. Dept. Agric. Tech. Bull. 785.
11. Englerth, G. H. 1942. Decay of Western Hemlock in Western Oregon and Washington. Yale School of Forestry, Bull. 50: 1–53.

12. Fries, Elias. 1822. Systema Mycologicum, 2 : 239–243.

13. Fritz, Clara W. 1923. Cultural Criteria for the Distinction of Wood-destroying Fungi. Trans. Royal Soc. Canada, pp. 191–288.

14. Gore, J. H. 1883. Tuckahoe or Indian Bread. Ann. Rep. for 1881. Smithsonian Inst., pp. 687–701.

15. Güssow, H. T. 1919. The Canadian Tuckahoe. Mycologia, 11 : 104–110.

16. Hubert, E. E. 1929. A Butt-Rot of Balsam Fir Caused by *Polyporus balsameus* Pk. Phytopathology, 19 : 725–731.

17. —— 1931. Outline of Forest Pathology, viii + 543. John Wiley & Sons, New York.

18. Humphrey, C. J., and Siggers, Paul. 1933. Temperature Relation of Wood-destroying Fungi. Journ. Agric. Res., 47 : 997–1008.

19. Jackson, L. W. R. 1945. Root Defects and Fungi Associated with the Little-Leaf Disease of Southern Pines. Phytopathology, 35 : 91–105.

20. Kaufert, Frank. 1935. Heart-Rot of Balsam Fir in the Lake States, with Special Reference to Forest Management. Tech. Bull. 110 : 1–27. Univ. Minn. Agric. Exper. Sta. in Coöperation with U. S. Forest Service.

21. Lloyd, C. J. 1916. Mycological Notes, No. 42.

22. Lockwood, Samuel. 1882. The Tuckahoe. Bull. Torr. Bot. Club, 9 : 152–153.

23. Murrill, W. A. 1908. North American Flora, 9, Part 2 : 73–131

24. —— 1922. Editor's Note. Mycologia, 14 : 92.

25. —— 1923. Poria Cocos (Schw.) Wolf. Mycologia, 15 : 105–106.

26. Overholts, L. O. 1942. The Polyporaceae of Pennsylvania III. The Genus Poria. Bull. 418 : 1–64. Penn. State College, School of Agriculture.

27. Rafinesque, C. S. 1830. Medical Flora of North America, 2 : 270.

28. Schrenk, H. von. 1907. Sap-Rot and Other Diseases of Red Gum. U. S. Dept. Agric., Bur. Plant Industry, Bull. 114 : 1–37.

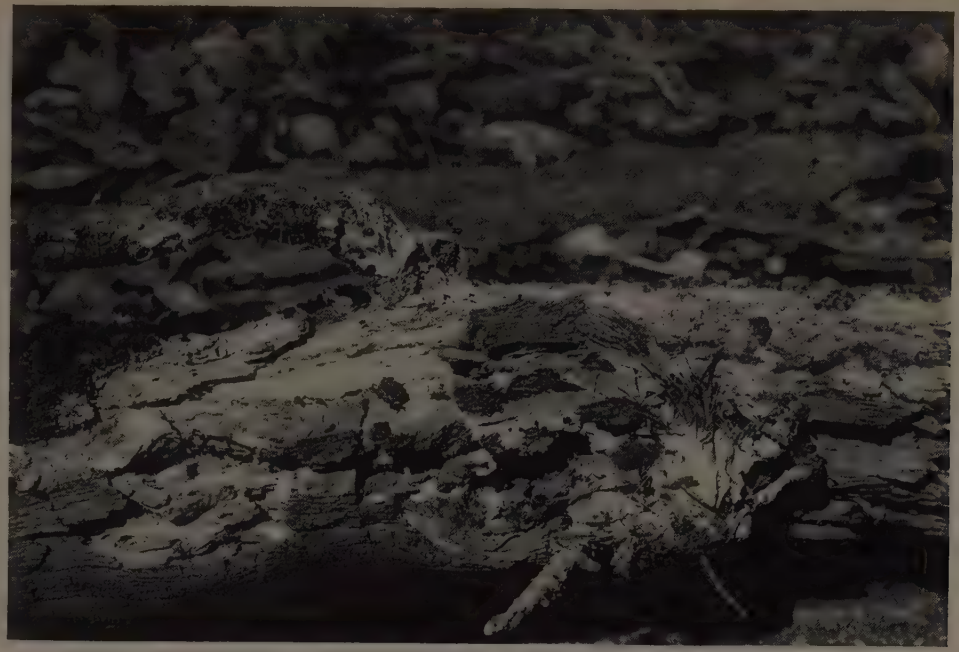
29. Shope, Paul Franklin. 1931. The Polyporaceae of Colorado. Ann. Mo. Bot. Garden, 18 : 287–456.

30. Weber, George F. 1929. The Occurrence of Tuckahoes and *Poria Cocos* in Florida. Mycologia, 21 : 125.

31. Weir, James R. 1914. Notes on Wood-destroying Fungi Which Grow on Both Coniferous and Deciduous Trees. I. Phytopathology, 4 : 271–276.

32. Wolf, F. A. 1922. The Fruiting State of the Tuckahoe Pachyma Cocos. Journ. Elisha Mitchell Sci. Soc., 38 : 127–138.

33. —— 1926. Tuckahoe on Maize. *Ibid.*, 41 : 288–290.



Poria quercuum sp. nov. on *Quercus stellata*, Branson, Missouri

Poria crustulina xerophyta var. nov. on *Torreya californica;* vicinity of Muir Woods, California

Poria Cocos on cornstalk, F. A. Wolf; Herbarium Mycological Collections, U. S. Bureau Plant Industry, Beltsville, Maryland

THE

HISTORY

AND

Present State

OF

VIRGINIA,

In Four PARTS.

I. The HISTORY of the First Settlement of *Virginia*, and the Government thereof, to the present Time.

II. The Natural Productions and Conveniencies of the Country, suited to Trade and Improvement.

III. The Native *Indians*, their Religion, Laws, and Customs, in War and Peace.

IV. The present State of the Country, as to the Polity of the Government, and the Improvements of the Land.

By a Native *and* Inhabitant *of the* PLACE.

LONDON:
Printed for *R. Parker*, at the *Unicorn*, under the *Piazza's* of the *Royal-Exchange*. MDCCV.

They have no Salt among them, but for seasoning, use the Ashes of Hiccory, Stickweed, or some other Wood or Plant, affording a Salt ash.

They delight much to feed on Roasting-ears; that is, the *Indian* Corn, gathered green and milky, before it is grown to its full bigness, and roasted before the Fire, in the Ear. For the sake of this Dyet, which they love exceedingly, they are very careful to procure all the several sorts of *Indian* Corn before mentioned, by which means they contrive to prolong their Season. And indeed this is a very sweet and pleasing Food.

They have growing near their Towns, Peaches, Strawberries, Cushawes, Melons, Pompions, Macocks, *&c.* The Cushaws and Pompions they lay by, which will keep several months good after they are gather'd; the Peaches they save, by drying them in the Sun; they have likewise several sorts of the *Phaseoli*.

In the Woods, they gather Chincapins, Chesnuts, Hiccories, and Walnuts. The Kernels of the Hiccories they beat in a Mortar with Water, and make a White Liquor like Milk, from whence they call our Milk *Hickory*. Hazlenuts they will not meddle with, tho they make a shift with Acorns sometimes, and eat all the other Fruits mentioned before, but they never eat any sort of Herbs or Leaves.

They make Food of another Fruit call'd *Cuttanimmons*, the Fruit of a kind of Arum, growing in the Marshes: They are like Boyl'd Peas, or Capers to look on, but of an insipid earthy taste. Captain *Smith* in his History of *Virginia* calls them *Ocoughtanamnis*, and *Theod. de Bry* in his Translation, *Sacquenummener*.

Out of the Ground they dig Trubbs, Earth-nuts, Wild Onions, and a Tuberous Root they call *Tuckahoe*, which while crude is of a very hot and virulent

The earliest reference to the tuckahoe in North American literature occurs in the last line of page 15 of the first edition (1705) of *The History and Present State of Virginia*, by Robert Beverly. From a copy in the William L. Clements Library, University of Michigan

Polyporus balsameus (resupinate) on *Abies balsamea,* Gander Lake, Newfoundland

Polyporus adustus (resupinate) on *Juglans nigra,* Jasper, Arkansas

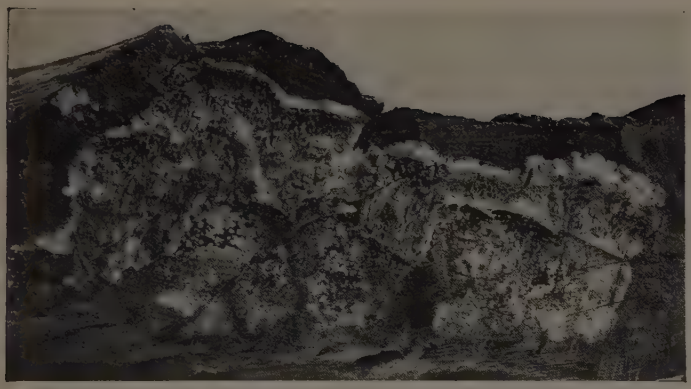


FIG. 1. *Polyporus biformis* on *Quercus marilandica*, Jasper, Arkansas

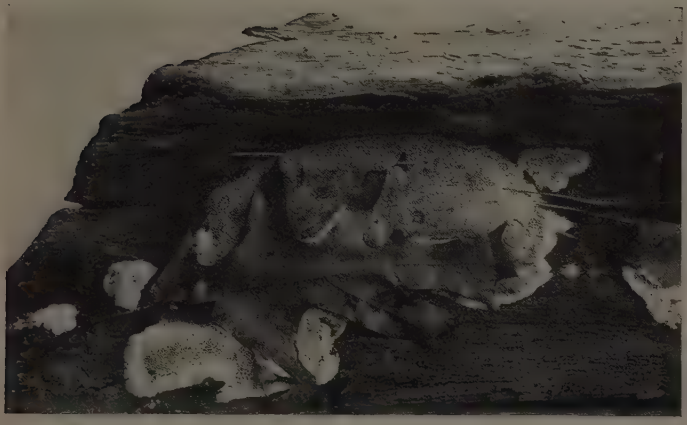


FIG. 2. *Polyporus biformis* (resupinate) on *Quercus marilandica*, Jasper, Arkansas

Poria ferox Long & Baxter on leaning trunk of live *Juniperus virginiana*, Mountain View, Arkansas

Juniper-oak association, Mountain View, Arkansas, habitat for *Poria ferox* Long & Baxter on juniper slash and wounded live juniper

FORESTRY IN SOIL CONSERVATION

ALBERT F. DODGE

WHEN a farmer applies to the local soil-conservation district for assistance he generally does so because he is confronted with some land-management situation with which he cannot cope or which he does not understand. Perhaps his legume hay yields are slowly decreasing on the good twenty despite assurances that legumes build up the soil. Possibly he wishes to bring a piece of practically idle muck land into production, but he is not certain that the soil is worth the expense of draining. He wants a windbreak for the farmstead and needs some guidance in the choice of species for the planting.

These are immediate problems which bring the farmer to the district for assistance. Prior to this problem he has long recognized differences in the various fields on his farm. Some fields which once grew acceptable cash crops are now thin or rocky, and their use may have been changed to the growing of hay or to pasturing. Certainly the best land, or a portion of the best, will be in row crops. These uses have come about largely for convenience, without much regard for soil structure, depth of topsoil, and availability or losses of plant nutrients.

If a farmer's application for assistance is approved by the governing body of the soil-conservation district, a conservationist from the Soil Conservation Service starts working with him. The farm boundaries are marked on an aerial photograph, and this information is turned over to the soil scientist, another technical employee assisting the local district. This scientist takes the aerial photograph and records the kinds of soil, the degree of slope, and the extent of erosion for the entire farm. This survey is a complete physical inventory of the farm-land conditions. With the inventory as a base, the soils on the farm are classified according to the best uses to which they may be put with least loss through erosion.

LAND CAPABILITY CLASSES

On the basis of these factors lands are grouped into eight classes with respect to the degree of hazard in their use. These land classes

provide an orderly guide for a permanent agriculture. If farm land is worked more intensively than is indicated in the following description, deterioration is inevitable (1).

Land Suitable for Cultivation

Class I. — Very good land that can safely be cultivated with ordinary good farming methods. It must be capable of producing moderately high yields of climatically adapted crops, and be free from stones which would impede cultivation. It is not subject to overflow or serious erosion. It must be well drained or capable of being drained to permit at least moderate yields.

Class II. — Land differing from that in Class I in that cultivation requires the adoption of some simple practices if the soil is to remain permanently productive. Some of these practices are: contour tillage, strip cropping, cover crops, crop rotation which includes grasses and legumes, one or two simple terraces or drainage ways, and the correction of inherently low fertility by the application of fertilizers.

Class III. — Moderately good land suitable for cultivation only when cultivation is supported by intensive conservation practices. Such practices include strip cropping, with narrow bands of annual crops alternating with strips of grasses and legumes; long crop rotation with clean-tilled crops held to a minimum; intensive terrace systems with outlets; diversion ditches to carry off excess water; and drainage systems that are difficult to install and maintain.

All cropland in Classes I, II, and III may require replacement of nutrient elements that have been removed by crops or lost by leaching. The need for soil treatments increases progressively in these three classes in order to maintain organic matter and to return moderate to high yields.

Land Suitable for Limited Cultivation

Class IV. — Steep land areas severely eroded or susceptible to deterioration and soil so imperfectly or excessively drained as to be unsuitable for row crops. This class is adapted to a grain crop every five or six years, which is to be followed by hay or pasture.

Land Suitable for Permanent Vegetation

Class V. — Land not subject to soil losses under ordinary use; in general, it is flat and too wet, cold, or stony for any cultivation. It will produce forage or wood crops.

Class VI. — Land that because of moderately steep slopes can be used permanently only for pasture or woods. On most farms this class will be pasture capable of being renovated, and under proper management will continue to supply forage for livestock.

Class VII. — Land that includes steep slopes, broken topography, thin or rocky soils, and badly gullied areas; requires severe restriction in use. In the humid regions of the East this class of land should be utilized for the production of wood crops because its restricted use and limited carrying capacity as pasture do not ordinarily warrant the expense of establishing and maintaining stands of forage plants.

Class VIII. — Primarily waste land and not suited for the production of any useful vegetation, but may have possibilities for wildlife and recreation. It often consists of rocky outcrops, barren land, or permanently wet marshes that cannot be drained.

With the delineation of the various fields or portions of fields into capability classes, it is possible to make sound land-use recommendations to the farmer. His crop and livestock needs can be adjusted accordingly, and his soil capital maintained. When site conditions require the protection of a forest cover, tree planting or woodland-management recommendations are given.

RETURNS FROM FARM WOODLAND

If a coöperator has land in Class I, II, III, or IV that is in woods or land best suited to remain as woods (Classes V, VI, VII), it is only natural that he should inquire about the probable returns from farm woodland operations. Farm-management studies have long recorded costs and returns for many farm enterprises. In the Middle West, at least, the farm woodland, as a part of the farm accounts, has largely been ignored. Recently the farm planner's fund of information on the returns from farm woodland work has been considerably enhanced.

In a report of 89 farm woodland operations in Ohio, Indiana, Michigan, Minnesota, and Iowa, Locke (2) and several resident farm foresters summarized 339 record years of income and expense. These data cover the six-year period 1940–45, during which the Soil Conservation Service administered part of the Norris-Doxey Act. Individual account books were carefully checked for volume differences, so that the records included in the summary reflect only regulated timber harvest. Heavy cut was one of the reasons why the 89 acceptable records represented only 30 per cent of all the records taken. All acceptable records were assembled according to average annual net return per acre and divided

into three groups, those with high, medium, and low incomes. The averages of income and expense for each group are presented in Table I. These data may be considered typical of three kinds of farms that are engaged in woods work with varying success.

It will be noted that wood products such as fuel, posts, poles, and lumber for the farm comprise a substantial part of the total value of

TABLE I

AVERAGE ANNUAL INCOME AND EXPENSE OF EIGHTY-NINE FARM WOODLANDS

Income and expense	High income from 25 woods (average)	Medium income from 39 woods (average)	Low income from 25 woods (average)
1. Income, home use	$156.14	$142.34	$107.63
2. Income, sales	434.42	16.96	14.62
3. Income, stumpage	103.46	24.66	2.60
4. Total gross income	694.02	183.96	124.85
5. Expenses, noncash	151.00	57.22	62.28
6. Expenses, cash	60.15	24.00	19.90
7. Taxes	14.21	8.13	10.01
8. Interest on investment (3%)	111.54	37.08	46.27
9. Total expenses	336.90	126.43	138.46
10. Net income	357.12	57.53	— 13.61
11. Net income per acre	8.50	1.92	— 0.23
12. Interest on investment	12.6%	7.6%	2.1%
13. Returns per hour of labor	1.33	0.67	0.26

products cut annually. Stumpage sales were handled as a separate item under income. The figure for them is deducted from income in computing return per hour of labor (line 13), since the coöperator's labor is not involved.

The returns for the use of the woodland are shown as net income per acre, interest on investment, and as returns per hour of labor. This last item is particularly valuable to the farm planner in encouraging the farmer coöperator to put his time into the woodland. Most farmers have worked for hourly wages, and income expressed in such terms has real meaning.

Poor tools, inadequate equipment, lack of experience and skill, and the fact that many of the farmers were starting woods work for the first time — all tended to make the net return low. Indeed, returns were negative for a number of farms. In some cases the farm forester actually advocated work without positive return value. The planting of

pine in openings and certain thinnings are examples of nonremunerative work suggested to improve woodland conditions.

The analysis of the individual records revealed the fact that an operator's managerial ability to utilize fully his labor in getting out woods products is more important than site quality as an income factor. If he ignores the woodland work, he loses the income regardless of site conditions.

The records of income from these eighty-nine farm woodlands indicate that time spent in the woods influences income. Farmers with high incomes from such operations put in more hours in their woods than those with lower incomes. (see Table II). In other words, more work in the woods means higher income.

TABLE II

TIME SPENT IN THE WOODLAND BY INCOME GROUPS

Income group	No. of acres in woodland (average)	No. of hours spent in woods (average)	Hours per acre (average)
High	42	287	6.8
Medium	30	125	4.1
Low	58	153	2.6

TABLE III

SIZE OF WOODLAND AND NET INCOME PER ACRE

Number of acres	Number of farms	Net income per acre (average)
4–20	33	$4.07
21–40	31	3.70
41–185	24	3.21

If a farmer attempts to operate more woods area than he can efficiently handle with his available labor, he either sells stumpage or allows the growth to accumulate. In either case the woods income suffers. Table III suggests that the size of the farm woodland is apparently correlated with income.

From the foregoing discussion it is evident that for the first time farm planners assisting soil-conservation districts have available income and expense data for the operation of farm woodland on a sound, regu-

lated basis. With this information they are encouraging Michigan farmers having woodlands to put their off-season labor into the harvesting of woods products. If the coöperator has trees of various sizes in his woodland and if he will regularly and wisely devote his time to harvesting and improving the woodland, he can be assured of an income which will be as good as or better than that from most other farm operations.

REFORESTATION

Tree planting by soil-conservation district coöperators is largely confined to evergreens—pines and some spruce. In most instances the actual work is done by the coöperators themselves. They follow the planting suggestions of the farm planner of the Soil Conservation Service. Stock for such plantings is obtained from the Michigan Conservation Department, from the Michigan State College Forestry Department Nursery, or from the local soil-conservation district.

Trees have been planted on 22,421 acres of eroded fields and gullies, land in Class VII. This has been done since 1938, when Michigan's first soil-conservation district, the West Ottawa Soil Conservation District, was organized. In 1946 some 3,576 acres were planted, but 31,930 acres of Class VII land on farms still remain to be planted.

Along or near the Lake Michigan shore tree planting has been recommended for 6,317 acres of dune or beach sand. Already 2,554 acres of this have been set to trees, 215 of which were planted in 1946. Sometimes it is necessary to stabilize the planting site with brush or beach grass prior to planting the pines. This serious erosion condition has been successfully controlled by individual coöperators working with the soil-conservation district.

To date coöperators and planning technicians have agreed on the use of 1,268 acres for windbreaks, of which 954 acres have already been set out.

Farmer coöperators in Michigan, operating more than 495,000 acres, have planted 25,929 acres to trees. Preliminary estimates of Michigan farm land best suited for tree planting, as taken from conservation survey data, are placed at 654,000 acres.

An interesting development in connection with this farm tree planting is the nursery operated by the soil-conservation district. The directors of three soil-conservation districts serving parts of Muskegon and Ottawa counties have been raising several kinds of pines from seed.

These seedlings are planted out in nursery rows for one or two seasons. Modified celery planters make this possible with a minimum of labor. Fully developed transplant stock is thus available within the district for any coöperator at a moderate cost without the hazards of common carrier shipment.

Seven other soil-conservation districts are operating lining-out nurseries at the present time. The advantages of this procedure are being considered by seven additional soil-conservation districts. During the 1945–46 planting season the ten active nurseries provided 1,273,000 transplanted conifers, which were largely pines. This was more than one third of the 3,398,000 trees planted by district coöperators. The rest of the stock came from state and federal nurseries.

The success of these plantings in Michigan may be attributed to the following factors:

1. Several soil-conservation districts actively encourage coöperator tree planting by growing transplant stock locally.
2. Nearly all Michigan soil-conservation districts obtain grants of stock from the Soil Conservation Service to encourage tree planting.
3. The coöperator obtains on the ground help from the resident planning technician of the soil-conservation service in choosing the proper trees for the planting site and in methods of caring for and planting the stock.

The plantings made by coöperating farmers in Michigan have generally been quite successful. For the country as a whole, according to Preston (3), soil-conservation district coöperators have enjoyed an average tree survival of better than 85 per cent.

U. S. Department of Agriculture
Soil Conservation Service
Allegan, Michigan

LITERATURE CITED

1. Hockensmith, R. D., and Steele, J. G. Classifying Land for Conservation Farming, Farmers' Bulletin No. 1853. U. S. Department of Agriculture, Washington, D.C., 1943.
2. Locke, Stanley S. Income from Farm Woodlands, Journ. Forestry, 43 (1945): 723–728.
3. Preston, John F. Needed: A Tree Planting Program, American Forests, 52 (1946): 460, 461, 486, 506, 507.

SOME RESULTS OF SELECTION CUTTING IN THE EBER WHITE WOODS, ANN ARBOR, MICHIGAN

LEIGH J. YOUNG
University of Michigan

HAROLD F. SCHOLZ
Lake States Forest Experiment Station

IN 1915, when the University of Michigan came into possession of the Eber White Woods near Ann Arbor, they represented a remnant of southern Michigan hardwood forest, modified to some extent by cutting, which had removed a number of the larger and, probably, more valuable trees. The condition of the stand at that time indicated that the area had not been grazed for at least a considerable period. Possibly it had never been grazed. There was also no evidence of damage from fire.

Except for three small wet depressions and a little Washtenaw loam in the northwest corner, the soil is Miami silt loam. As this is a better soil than that of the average woodlot in this locality, the stand has a more complex composition. Among the trees of merchantable size oaks and hickories predominated. White ash, basswood, sugar maple, and elms were less abundant, but were well represented throughout the stand. Other species occurred in much smaller numbers and included black walnut, butternut, black and blue ash, black cherry, yellow poplar, aspen, sassafras, Kentucky coffee tree, cottonwood, red maple, and juneberry. A complete list of the common and scientific names of the species is given at the end of this paper.

At the time of acquisition there was an understory of small trees, consisting almost entirely of ironwood, with a sprinkling of blue beech, dogwood, and hawthorn. In the southern half of the woods this understory was so dense throughout that it had almost entirely prevented the reproduction of other species. But in the northern portion it was more open and irregularly distributed.

The stand was decidedly uneven-aged, but without an equal distribution of age classes. The large-pole class was particularly deficient in relation to the others. All diameter classes were present up to a maximum of 44 inches. The best dominants reached a height of 90 feet.

FORM AND CONDITION OF TREES

The number of trees with pronounced crook was larger than desirable. In fact, they were so numerous that they almost obscured the presence of the many straight, well-formed individuals.

In general, the trees of saw-timber size were poorly cleaned, and this was particularly true of the trees above 30 inches in diameter. The crowns of these oldest trees were very wide, with heavy branches. A clear length of more than two 16-foot logs was exceptional. Many of the largest individuals were overmature and had become stag-headed.

Heart rots had caused defect to an average amount of about 20 per cent, though in some of the veterans, ranging in age from 200 to 300 years, the heartwood was practically all decayed.

CUTTING POLICY

As the original plan was to operate on a ten-year cutting cycle, the area was divided into ten compartments of 4.3 acres each. The compartments were to be cut successively at the rate of one each year. However, after compartments 1 to 5 inclusive had been cut, it appeared desirable to cut again in these compartments to secure a more rapid reduction in the amount of ironwood and a quicker release of reproduction of the more valuable species. Defective trees in need of salvaging were cut at the same time. Compartment 6 received its first cut that same year. Since that time cutting has been done in two compartments each year, with the heavier cuts made at ten-year intervals. Present conditions are such that the lighter cuts at the intermediate five-year intervals can be abandoned.

The earlier cuts were made on a single-tree selection basis, with the major emphasis on stand improvement in all age classes and with no attempt to secure a strict regulation of volume removed. After each compartment has been marked for cutting, the diameters of all trees have been measured, with separate tallies of the trees cut and those to be left. The minimum diameter measured has been a full inch. This procedure has provided a check on the relation between the growth in

basal area and the amount cut at the five-year intervals, and has also made it possible to learn at what rate reproduction was working up into the larger size classes.

Later, whenever the distribution of the larger trees has been favorable, cutting of groups has been practiced to reduce logging damage to young growth and to provide better conditions for the reproduction of the less tolerant, light-seeded species.

There has been one deliberate violation of good silviculture in that a considerable number of the very large, overmature oaks have been retained until there was very definite evidence that they were decadent. On compartment 3, however, all trees of this class have been cut.

Trees of weed species have not been cut unless they were large enough to produce salable wood or were interfering with the development of individuals of better species. A complete removal of the weed species would be expensive and would frequently result in too much reduction in the crown density needed to maintain good forest conditions. Small trees of weed species growing under the crowns of large trees are left undisturbed until the large trees have been cut.

One objective of the cutting policy has been to increase the volume of the growing stock as much as possible and to improve its quality both in composition and in the character of individual trees. Another has been to maintain conditions favorable to adequate reproduction. After the major part of the necessary improvement work has been completed, attention must be given to securing a better distribution of age classes. The conversion of a stand, such as this one was in 1917, into a well-stocked, high-quality, well-regulated woods by the use of the selection method is a discouragingly slow process.

Because of a good local demand for firewood, utilization has been very close, and slash disposal has not been a problem.

REPRODUCTION

With respect to the number of trees, reproduction has been more than adequate, but there has been a wide variation in the degree to which the various species are represented. A systematic study, with the use of milacre quadrats, was made in 1934.[1] This showed that 67 per cent of the trees less than 10 feet in height consisted of white ash, sugar maple, basswood, and black cherry. Ironwood and dogwood amounted

[1] Feeman, Abram L., "Study of Reproduction in the Eber White Woods," 1934. Unpublished manuscript.

to nearly 25 per cent. White ash led all the species in the number of trees and extent of distribution, with sugar maple second and black cherry and basswood practically tied for third place. There is no evidence of any material change since that time. On some areas reproduction of these species has entirely replaced the former understory of ironwood.

Although the oaks and hickories predominate among the older trees of the stand, reproduction of these species is almost negligible in amount. Several factors are responsible for this condition, but it is not known to what extent each one has operated. Close proximity to the city of Ann Arbor results in a heavy collection of the edible hickories and walnuts. Squirrels undoubtedly cause a further loss of seed of all the heavy-seeded species. Even if some of these seeds are left to germinate, the rather high density of most of the stand causes their early suppression. In some places white oak and hickories have reached sapling size, only to be driven out by the more rapidly growing ash, basswood, and cherry.

On a few small areas dense thickets of witch hazel and gray dogwood have caused a failure of reproduction.

At the time that management of the woods was started reproduction was lacking along the west and south boundaries on strips about a hundred feet in width. Most of the leaf litter was blown from these strips, and a rather heavy cover of grass had developed. An effort was made to establish a windbreak along these two boundaries by planting white and Scotch pines, but before these had grown enough to have any appreciable effect ironwood had started to invade the open areas. As it increased in density, the grass was shaded out, and other species were able to get started. At present these formerly open strips are almost completely restocked, though ironwood still predominates strongly.

EFFECTS OF CUTTING UPON STOCKING

In the following tables, which show the various effects of management, the data for compartments 1–5 and those for 6–10 are given separately, because the former group of compartments sustained a total of 27 cutting operations and the latter only 21.

The data in Table I show the effect of management upon the number of trees per acre by species in two classes — total number of all diameters and number of sawlog trees only. The figures given in the "1917" column do not represent the condition in all compartments in that year, but are averages of the number of trees present in the com-

partments of each group at the time of the first cut. In the same way the "1942" figures represent the situation at the time of the last cut.

In the entire woods there was an increase of 27.9 per cent in the total number of trees of the species listed as commercial, but a decrease of 1.4 per cent in the number of trees in the sawlog class. The total number of ironwood has decreased 38.5 per cent, but there are still 160 to the acre, compared to a total of 381 trees of the commercial species. This is not so bad as it looks, since most of the ironwood are small, have low vigor, and exert little influence on the remainder of the stand. The largest increases have been in ash, sugar maple, and black cherry, whereas red oak, elm, and hickory have decreased in number.

The extent to which figures alone fail to bring out the whole story in a case like this can be illustrated by those for basswood. In compartments 1–5 basswood has decreased by 8.7 per cent, but in compartments 6–10 it has increased by 11.4 per cent. One reason for this is that reproduction of basswood started earlier in the first group of compartments and has reached such a size and density that thinning has been necessary. In the second group of compartments little thinning of basswood reproduction has been done. Many of the old basswood that were sources of seed in the earlier years have been removed because of decadence, so that new reproduction of this species will be lacking in some portions of the area until the young trees now developing have reached the age of good seed production.

The figures in Table I also indicate the changes in composition in the stand. Taking the total number of trees of the commercial species only, we find that the percentage representation of each one at the beginning of operations was as follows: red oak, 12.5; white oak 5.2; ash, 11.2; basswood, 26.8; sugar maple, 5.4; elm, 18.4; black cherry, 4.4; black walnut, 1.2; and hickory, 14.7. In 1942 the percentages had become: red oak, 9.5; white oak, 4.3; ash, 23.0; basswood, 23.3; sugar maple, 10.0; elm, 10.5; black cherry, 8.2; black walnut, 1.3; and hickory 9.6. Of the trees of sawlog size in 1942 red oak made up 49.5 per cent, hickory, 20.6 per cent; white oak, 12.4 per cent; sugar maple, 5.3 per cent, a total of 87.8 per cent for these four species. But these same species composed only 33.4 per cent of the total number of trees of all sizes.

EFFECTS OF CUTTING UPON BASAL AREA AND VOLUME

By inspection of the data in Table III it will be found that cutting has caused a decrease in the basal area and gross volume of all size

classes, except the standards, and of the stand as a whole. Of the total decrease in basal area of the four size classes affected in that way the decrease in the veteran class constituted 61.2 per cent. If all the veterans had been removed at the first cut, the reduction in the total basal area might have been still greater, though part of it would have been offset by the more rapid growth of younger trees that could have occupied the areas covered by the veterans.

After the last cut the percentage distribution of the total cubic volume among the different size classes was: reproduction, 8.4; small poles, 7.0; large poles, 13.3; standards, 54.3; and veterans, 17.0.

DISTRIBUTION OF VOLUME BY SPECIES

Table IV shows the extent to which the oaks and hickories predominate in the total volume of the stand in both cubic and board feet. In total cubic volume of commercial species these species compose 75.2 per cent. This predominance of oaks and hickories occurs in all size classes, except reproduction and small poles. In reproduction, ash and basswood lead with percentages of 27.7 and 27.4, respectively. Basswood, hickory, elm, and ash are the chief species in the small-pole class, with percentages of 27.6, 17.3, 17.1, and 14.0, respectively. Ironwood is now only 3.5 per cent of the total cubic volume of the stand but still makes up 31.1 per cent of the volume in the reproduction class.

CHARACTER OF CUTTING

Some idea of the character of the cutting, especially the extent of work done in the smaller size classes, can be obtained from Table II.

Of the total number of trees cut, 83.5 per cent were in the reproduction class and 11.9 per cent were small poles. In cubic volume the cut in these two classes amounted to 23.2 per cent of the total. The largest part of the cut came from the veterans — 40.5 per cent. Standards ranked second with 28.2 per cent.

The distribution of the cut by species and size classes on the basis of number of trees removed is shown in Tables V and VI. This analysis brings out a number of important points.

Most of the red oaks cut were standards, whereas the heaviest cutting of all the other species, except black walnut and white oak, was in reproduction. In the case of ironwood over 90 per cent of the trees cut was in this class. More white oaks were cut in the small-pole class than in any other one.

Nearly 70 per cent of the trees cut in the reproduction class was ironwood. This species also led in small poles cut with 47 per cent. Hickory was second with 22.6 per cent. Hickory (36 per cent) and red oak (22.8 per cent) contributed the bulk of the cut in large poles. Of standards cut, red oak, hickory, and sugar maple made up over 70 per cent, but in the veterans class, white oak, basswood, and red oak, in that order, led in number of trees cut with a total of 82.6 per cent.

GROWTH IN BASAL AREA AND VOLUME

The growth figures as given in Table VII are not exactly encouraging, but in a stand cut and measured as this one has been, they do not represent the true results. They are included in this paper, however, to indicate how much in error this rather usual method of calculation can be in a case such as this one.

If the mean annual growth in basal area is computed for each compartment separately and for the period actually covered by the measurements, it is found that the best growth occurred in compartment 1, with a mean of 2.234 square feet, and the poorest in compartment 9, where the mean was 1.505. The mean for the entire woods was 1.799.

As a result of differences in the degree of cutting, the kinds of trees removed, weather conditions, and possibly other factors, there has been a marked fluctuation in growth in each compartment during each of the five-year periods. For example, basal area growth in compartment 2 varied as follows: 1924–28, 9.68 square feet; 1929–33, 11.175 square feet; 1934–38, 3.538 square feet. The basal areas cut from this compartment before each growth period were 5.25, 4.31, and 6.85 square feet respectively. In contrast, the similar figures for compartment 3 were: 1925–29, 9.13; 1930–34, 8.26; 1935–39, 9.01. In percentage basal area growth for a single five-year period has varied from 1.8 to 3.9. The best growth for a single five-year perior was 17.81 square feet.

It is possible that the growth rate might have been improved by a more rapid removal of the mature and overmature trees and their replacement with young and vigorous ones. This was tried in compartment 3, where all the old and overmature trees were cut in 1929, except seven that ranged in diameter from 23 to 29 inches. Some of these trees were left because they were needed as a source of seed. Because of the time required for reproduction to become established in the openings made by cutting large trees and to develop to the point of contributing to the volume of the stand, it is still too early to get an

answer from this experiment. Further, owing to war conditions there has been no measurement of this compartment since 1939.

The woods has served as a study and experimental area in which students have been able to practice marking, observe the results of cutting operations, and gain some experience in the use of the axe and saw. Because all cutting has been done by student labor and carried out primarily as an educational project, the financial results have little value as a demonstration of what might be done with such a woods commercially.

SUMMARY OF RESULTS

Reproduction of the more valuable species has been sufficient to maintain good stocking and has consisted predominantly of a few light-seeded species.

The percentage of inferior species and of poorly formed, decadent trees has been considerably reduced.

The total gross volume of the growing stock has been temporarily decreased as a result of heavier cutting of the older trees in recent years.

A proper distribution of age classes has not been accomplished.

The mean annual increment has been low, owing partly to the presence of too many overmature trees and partly to the fact that many of the younger trees have not yet reached the age of rapid growth.

LIST OF SPECIES

COMMON NAME	SCIENTIFIC NAME
Ash, black	Fraxinus nigra
Ash, blue	Fraxinus quadrangulata
Ash, white	Fraxinus americana
Aspen, trembling	Populus tremuloides
Basswood	Tilia americana
Beech, blue	Carpinus caroliniana
Cherry, black	Prunus serotina
Coffee tree, Kentucky	Gymnocladus dioicus
Cottonwood	Populus deltoides
Dogwood, flowering	Cornus florida
Elm, red	Ulmus fulva
Elm, white	Ulmus americana
Fir, Douglas	Pseudotsuga taxifolia
Hawthorn	Crataegus sp.
Hickory, bitternut	Carya cordiformis
Hickory, mockernut	Carya ovata
Hickory, pignut	Carya glabra

COMMON NAME	SCIENTIFIC NAME
Ironwood	Ostrya virginiana
Juneberry	Amelanchier canadensis
Maple, red	Acer rubrum
Maple, sugar	Acer saccharum
Oak, black	Quercus velutina
Oak, bur	Quercus macrocarpa
Oak, chinquapin	Quercus Mühlenbergii
Oak, northern red	Quercus borealis var. maxima
Oak, swamp white	Quercus bicolor
Oak, white	Quercus alba
Pine, Scotch	Pinus sylvestris
Pine, white	Pinus strobus
Poplar, yellow	Liriodendron tulipifera
Sassafras	Sassafras albidum
Walnut, black	Juglans nigra

TABLE I

EFFECT OF MANAGEMENT UPON THE TOTAL STEMS PER ACRE

Species	All trees				Sawlog trees 10″ DBH or more			
	1917	1942	Increase	Decrease	1917	1942	Increase	Decrease
	No.	No.	Pct.	Pct.	No.	No.	Pct.	Pct.
COMPARTMENTS 1–5								
Commercial								
Red oak*	35.9	30.4	...	15.3	20.7	19.1	...	7.7
White oak†	16.9	18.9	11.8	...	4.8	5.4	12.5	...
Ash‡	43.4	99.1	128.3	...	1.9	1.8	...	5.3
Basswood	92.3	84.3	...	8.7	1.7	1.0	...	41.2
Sugar maple	20.1	57.7	187.1	...	2.5	1.7	...	32.0
Elm§	73.4	39.8	...	45.8	1.1	1.0	...	9.1
Black cherry	5.2	10.1	94.2	...	0.3	0.2	...	33.3
Black walnut	2.6	3.2	23.1	...	1.1	1.5	36.4	...
Hickory	50.7	39.6	...	21.9	5.2	7.5	44.2	...
Total	340.5	383.1	12.5		39.3	39.2		0.3
Miscellaneous								
Other‖	26.0	20.0	...	23.1	0.2	0.3	50.0	...
Ironwood	433.6	195.1	...	55.0	0.1	0.0	...	100.0
Total	459.6	215.1		53.2	0.3	0.3		
COMPARTMENTS 6–10								
Commercial								
Red oak*	39.0	42.8	9.7	...	22.9	21.7	...	5.2
White oak†	14.3	13.9	...	2.8	3.7	4.7	27.0	...
Ash ¶	23.2	76.5	229.7	...	1.6	1.1	...	31.2
Basswood	67.3	93.5	38.9	...	1.2	1.0	...	16.7
Sugar maple	12.0	18.6	55.0	...	3.6	2.7	...	25.0
Elm§	36.6	40.3	10.1	...	1.1	1.3	18.2	...
Black cherry	21.4	53.1	148.1	...	0.3	0.2	...	33.3
Black walnut	4.4	7.0	59.1	...	0.8	0.8	...	...
Hickory	37.2	33.8	...	9.1	9.4	9.6	2.1	...
Total	255.4	379.5	48.6		44.6	43.1		3.4
Miscellaneous								
Other**	35.6	24.6	...	30.9	0.7	0.6	...	14.3
Ironwood	87.5	125.6	43.5	...	0.0	0.0	...	...
Total	123.1	150.2	22.0		0.7	0.6		14.3
COMPARTMENTS 1–10								
Commercial								
Red oak*	37.4	36.6	...	2.1	21.8	10.4	...	6.4
White oak†	15.6	16.4	5.1	...	4.3	5.1	18.6	...
Ash	33.3	87.8	163.7	...	1.7	1.4	...	17.6
Basswood	79.8	88.9	11.4	...	1.4	1.0	...	28.6
Sugar maple	16.1	38.1	136.6	...	3.0	2.2	...	26.7
Elm§	55.0	40.0	...	27.3	1.1	1.2	9.1	...
Black cherry	13.3	31.6	137.6	...	0.3	0.2	...	33.3
Black walnut	3.5	5.1	45.7	...	0.9	1.2	33.3	...
Hickory	44.0	36.7	...	16.6	7.3	8.5	16.4	...
Total	298.0	381.2	27.9		41.8	41.2		1.4
Miscellaneous								
Other††	30.8	22.3	...	27.6	0.5	0.4	...	20.0
Ironwood	260.5	160.3	...	38.5	0.1	0.0	...	100.0
Total	291.3	182.6		37.3	0.6	0.4		33.3

TABLE II

NUMBER, BASAL AREA, AND VOLUME OF TREES CUT PER ACRE DURING THE PERIOD 1917–42

Size Class	Total trees	Total basal area	Total gross volume	
	Number	Square feet	Cu. ft.	Bd. ft.*
COMPARTMENTS 1–5				
Reproduction	418.3	8.150	170.8	...
Small poles	54.7	7.035	127.4	...
Large poles	7.5	3.333	74.5	86
Standards	6.5	9.064	294.4	989
Veterans	2.9	13.779	483.3	1954
Total	489.9	41.361	1150.4	3029
COMPARTMENTS 6–10				
Reproduction	168.8	2.851	59.7	...
Small poles	29.7	4.297	76.5	...
Large poles	7.4	3.438	77.2	121
Standards	5.6	7.721	233.9	859
Veterans	1.7	7.892	275.7	1125
Total	213.2	26.199	723.0	2105
COMPARTMENTS 1–10				
Reproduction	293.5	5.498	115.2	...
Small poles	42.1	5.666	102.0	...
Large poles	7.5	3.386	75.9	104
Standards	6.0	8.394	264.0	918
Veterans	2.3	10.838	379.4	1540
Total	351.4	33.782	936.5	2562

* Scribner Log Rule.

NOTES TO TABLE I

* Includes black oak.

† Includes swamp white, bur, and chinquapin oaks.

‡ Mostly white ash (on 21.5 acres 4 out of a total of 2,130 stems were black ash).

§ Includes both American and red elms.

‖ Principally dogwood (56 per cent), blue beech (23 per cent), and soft maple (16 per cent). The remainder (5 per cent) is Amelanchier, aspen, cottonwood, Kentucky coffee tree, and sassafras.

¶ Predominantly white ash (on 21.5 acres 1,644 ash were tallied. Of this total 1,410 were white ash, 190 blue ash, and 44 black ash).

** Principally dogwood (38 per cent), blue beech (42 per cent), and soft maple (17 per cent). The remainder (3 per cent) is butternut and tulip poplar.

†† Mostly dogwood (46 per cent), blue beech (33 per cent), and soft maple (17 per cent). The balance (4 per cent) is butternut, Kentucky coffee tree, aspen, Amelanchier, sassafras, cottonwood, and tulip poplar.

TABLE III

TOTAL BASAL AREA AND GROSS VOLUME PER ACRE PRIOR TO THE FIRST CUTTING AND AFTER THE FINAL CUTTING

Size Class*	TOTAL GROSS VOLUME					
	Total basal area		Cubic feet		Board feet§	
	Before the first cut†	After the last cut‡	Before the first cut†	After the last cut‡	Before the first cut†	After the last cut‡
COMPARTMENTS 1–5						
Reproduction	11.905	8.806	249.2	188.5	...	...
Small poles	10.449	9.697	190.4	164.2	...	...
Large poles	14.021	11.258	321.1	259.5	491	421
Standards	28.770	36.125	849.9	1084.2	2889	3822
Veterans	17.703	7.768	617.4	264.8	2552	1085
Total	82.848	73.654	2228.0	1961.2	5932	5328
COMPARTMENTS 6–10						
Reproduction	4.146	6.952	85.5	149.1	...	...
Small poles	8.257	7.017	144.1	118.4	...	...
Large poles	15.518	12.038	358.5	276.9	615	453
Standards	34.448	37.047	1025.1	1102.3	3497	3817
Veterans	15.708	12.203	555.3	417.5	2279	1713
Total	78.077	75.257	2168.5	2064.2	6391	5983
COMPARTMENTS 1–10						
Reproduction	8.026	7.879	167.4	168.8	...	...
Small poles	9.353	8.357	167.2	141.3	...	...
Large poles	14.770	11.648	339.8	268.2	553	437
Standards	31.609	36.586	937.5	1093.2	3193	3819
Veterans	16.705	9.985	586.3	341.2	2416	1399
Total	80.463	74.455	2198.2	2012.7	6162	5655

* Reproduction, 1-3 inches in diameter; small poles, 4-7 inches; large poles, 8-11 inches; standards, 12-22 inches; veterans, 23 inches and larger.

† Silvicultural cuttings were initiated in compartments 1-5 in 1917 and in compartments 6-10 in 1922.

‡ The final cuttings in compartments 1-5 and 6-10 were made in the winter of 1942–43.

§ By the Scribner Log Rule.

TABLE IV

GROSS CUBIC-FOOT AND BOARD-FOOT VOLUMES PER ACRE BY SPECIES AND D.B.H. CLASSES AT THE END OF 1942

Species	D.B.H. class in inches									
	1-3		4-7		8-11		12-22		23 or more		Total	
	Gross Volume*									
	Cu. ft.	Cu. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.	Cu. ft.	Bd. ft.
Compartments 1–5										
Commercial										
Red oak	4.0	2.6	49.5	110	651.7	2321	95.6	406	803.4	2837
White Oak	3.7	10.8	36.4	50	128.1	438	112.6	446	291.6	934
Ash	34.0	22.9	13.9	21	42.6	148	10.2	43	123.6	212
Basswood	27.4	38.4	21.3	16	13.6	43	16.9	70	117.6	129
Sugar maple	18.0	7.9	10.5	17	41.6	141	17.0	70	95.0	228
Elm	13.3	24.1	16.4	25	16.3	58	0.0	0	70.1	83
Black cherry	2.3	2.3	0.6	2	7.2	27	0.0	0	12.4	29
Black walnut	0.4	1.6	4.9	11	53.2	196	12.5	50	72.6	257
Hickory	8.0	25.9	100.7	164	124.4	430	0.0	0	259.0	594
Total	111.1	136.5	254.2	416	1078.7	3802	264.8	1085	1845.3	5303
Miscellaneous										
Other	4.1	6.5	5.3	5	5.5	20	0.0	0	21.4	25
Ironwood	73.3	21.2	0.0	0	0.0	0	0.0	0	94.5	0
Total	77.4	27.7	5.3	5	5.5	20	0.0	0	115.9	25
Grand total	188.5	164.2	259.5	421	1084.2	3822	264.8	1085	1961.2	5328
Compartments 6–10										
Commercial										
Red oak	6.3	5.7	81.6	166	630.7	2194	140.3	589	864.6	2949
White oak	1.0	12.7	30.6	47	90.0	330	218.9	883	353.2	1260
Ash	26.8	12.1	5.4	8	35.6	125	0.0	0	79.9	133
Basswood	32.6	30.4	10.5	10	17.1	57	21.3	90	111.9	157
Sugar maple	4.4	2.8	19.5	37	51.5	164	4.8	21	83.0	222
Elm	13.5	18.5	20.3	21	24.4	84	21.5	85	98.2	190
Black cherry	18.0	8.9	3.9	4	6.0	21	0.0	0	36.8	25
Black walnut	1.8	4.5	3.5	2	38.4	146	0.0	0	48.2	148
Hickory	4.5	17.0	97.0	153	196.7	656	0.0	0	315.2	809
Total	108.9	112.6	272.3	448	1090.4	3777	406.8	1668	1991.0	5893
Miscellaneous										
Other	5.6	2.9	4.3	5	11.9	40	10.7	45	35.4	90
Ironwood	34.6	2.9	0.3	0	0.0	0	0.0	0	37.8	0
Total	40.2	5.8	4.6	5	11.9	40	10.7	45	73.2	90
Grand total	149.1	118.4	276.9	453	1102.3	3817	417.5	1713	2064.2	5983
Compartments 1–10										
Commercial										
Red oak	5.1	4.1	65.5	139	641.1	2258	118.0	497	833.8	2894
White oak	2.4	11.7	33.5	48	109.1	383	165.8	664	322.5	1095
Ash	30.4	17.5	9.6	14	39.1	137	5.1	22	101.7	173
Basswood	30.1	34.5	15.9	13	15.3	50	19.1	80	114.9	143
Sugar maple	11.2	5.4	15.0	27	46.5	152	10.9	46	89.0	225
Elm	13.3	21.4	18.4	23	20.3	71	10.8	43	84.2	137
Black cherry	10.1	5.5	2.3	3	6.6	24	0.0	0	24.5	27
Black walnut	1.1	3.1	4.2	6	45.8	171	6.2	25	60.4	202
Hickory	6.2	21.6	98.8	159	160.7	543	0.0	0	287.3	702
Total	109.9	124.8	263.2	432	1084.5	3789	335.9	1377	1918.3	5598
Miscellaneous										
Other	4.9	4.6	4.8	5	8.7	30	5.3	22	28.3	57
Ironwood	54.0	11.9	0.2	0	0.0	0	0.0	0	66.1	0
Total	58.9	16.5	5.0	5	8.7	30	5.3	22	94.4	57
Grand total	168.8	141.3	268.2	437	1093.2	3819	341.2	1399	2012.7	5655

* Cubic foot volume is the total volume in all trees from 1 inch to 36 inches; board-foot volume is merchantable volume by the Scribner Log Rule.

TABLE V

NUMBER AND PERCENTAGE OF TREES, BY D.B.H. CLASSES AND SPECIES, REMOVED PER ACRE DURING THE PERIOD 1917–42

Species	D.B.H. class in inches											
	1–3		4–7		8–11		12–22		23 and larger		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
COMPARTMENTS 1–5												
Commercial												
Red oak*	0.4	9.1	0.5	11.4	1.1	25.0	1.8	40.9	0.6	13.6	4.4	100.0
White oak	2.9	40.8	2.4	33.8	0.7	9.9	0.4	5.6	0.7	9.9	7.1	100.0
Ash†	10.0	84.8	1.1	9.3	0.4	3.4	0.3	2.5	0.0	0.0	11.8	100.0
Basswood	30.6	78.5	5.4	13.8	0.7	1.8	1.1	2.8	1.2	3.1	39.0	100.0
Sugar maple	3.4	59.6	0.7	12.3	0.5	8.8	1.1	19.3	0.0	0.0	5.7	100.0
Elm‡	24.3	82.9	3.7	12.6	0.5	1.7	0.5	1.7	0.3	1.0	29.3	100.0
Black cherry	7.5	89.3	0.7	8.3	0.1	1.2	0.1	1.2	0.0	0.0	8.4	100.0
Black walnut	0.0	0.0	0.1	33.3	0.1	33.3	0.1	33.4	0.0	0.0	0.3	100.0
Hickory	9.6	46.6	7.4	35.9	2.5	12.1	1.0	4.9	0.1	0.5	20.6	100.0
Total	88.7	70.0	22.0	17.4	6.6	5.2	6.4	5.1	2.9	2.3	126.6	100.0
Miscellaneous												
Other§	21.3	95.1	1.0	4.5	0.0	0.0	0.1	0.4	0.0	0.0	22.4	100.0
Ironwood	308.3	90.4	31.7	9.3	0.9	0.3	0.0	0.0	0.0	0.0	340.9	100.0
Total	329.6	90.8	32.7	9.0	0.9	0.2	0.1	0.0	0.0	0.0	363.3	100.0
Grand Total	418.3	85.4	54.7	11.2	7.5	1.5	6.5	1.3	2.9	0.6	489.9	100.0
COMPARTMENTS 6–10												
Commercial												
Red oak*	0.7	9.2	1.9	25.0	2.6	34.2	2.2	28.9	0.2	2.7	7.6	100.0
White oak	0.8	16.7	2.8	58.3	0.2	4.2	0.0	0.0	1.0	20.8	4.8	100.0
Ash†	6.9	84.1	0.8	9.8	0.3	3.7	0.1	1.2	0.1	1.2	8.2	100.0
Basswood	17.7	96.2	0.5	2.7	0.0	0.0	0.0	0.0	0.2	1.1	18.4	100.0
Sugar maple	4.1	59.4	1.1	16.0	1.0	14.5	0.7	10.1	0.0	0.0	6.9	100.0
Elm‡	23.3	88.9	2.3	8.8	0.3	1.1	0.1	0.4	0.2	0.8	26.2	100.0
Black cherry	15.5	95.7	0.3	1.9	0.0	0.0	0.4	2.4	0.0	0.0	16.2	100.0
Black walnut	0.0	0.0	0.0	0.0	0.0	0.0	0.5	100.0	0.0	0.0	0.5	100.0
Hickory	5.4	22.9	13.8	58.5	2.8	11.8	1.6	6.8	0.0	0.0	23.6	100.0
Total	74.4	66.2	23.5	20.9	7.2	6.4	5.6	5.0	1.7	1.5	112.4	100.0
Miscellaneous												
Other§	22.1	96.1	0.9	3.9	0.0	0.0	0.0	0.0	0.0	0.0	23.0	100.0
Ironwood	72.3	92.9	5.3	6.8	0.2	0.3	0.0	0.0	0.0	0.0	77.8	100.0
Total	94.4	93.7	6.2	6.1	0.2	0.2	0.0	0.0	0.0	0.0	100.8	100.0
Grand total	168.8	79.2	29.7	13.9	7.4	3.5	5.6	2.6	1.7	0.8	213.2	100.0

TABLE V (*concluded*)

Species	D.B.H. class in inches											
	1–3		4–7		8–11		12–22		23 and larger		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
	COMPARTMENTS 1–10											
Commercial												
Red oak*	0.6	10.5	1.0	17.6	1.7	29.8	2.0	35.1	0.4	7.0	5.7	100.0
White oak	1.8	31.6	2.4	42.1	0.5	8.8	0.2	3.5	0.8	14.0	5.7	100.0
Ash†	8.8	84.6	1.0	9.6	0.3	2.9	0.2	1.9	0.1	1.0	10.4	100.0
Basswood	24.6	83.7	3.2	10.9	0.4	1.3	0.5	1.7	0.7	2.4	29.4	100.0
Sugar maple	3.8	61.3	0.8	12.9	0.7	11.3	0.9	14.5	0.0	0.0	6.2	100.0
Elm‡	24.4	86.2	3.0	10.6	0.4	1.4	0.3	1.1	0.2	0.7	28.3	100.0
Black cherry	12.1	93.8	0.5	3.9	0.1	0.8	0.2	1.5	0.0	0.0	12.9	100.0
Black walnut	0.0	0.0	0.0	0.0	0.1	25.0	0.3	75.0	0.0	0.0	0.4	100.0
Hickory	7.6	35.9	9.5	44.8	2.7	12.7	1.3	6.1	0.1	0.5	21.2	100.0
Total	83.7	69.7	21.4	17.8	6.9	5.7	5.9	4.9	2.3	1.9	120.2	100.0
Miscellaneous												
Other§	22.3	95.7	0.9	3.9	0.0	0.0	0.1	0.4	0.0	0.0	23.3	100.0
Ironwood	187.5	90.2	19.8	9.5	0.6	0.3	0.0	0.0	0.0	0.0	207.9	100.0
Total	209.8	90.7	20.7	9.0	0.6	0.3	0.1	0.0	0.0	0.0	231.2	100.0
Grand total	293.5	83.5	42.1	12.0	7.5	2.1	6.0	1.7	2.3	0.7	351.4	100.0

* Includes black oak. † Predominantly white ash. ‡ Includes both American and red elms.
§ Includes blue beech, soft maple, butternut, hawthorn, dogwood, and sassafras.

TABLE VI

NUMBER AND PERCENTAGE OF TREES, BY SPECIES AND D.B.H. CLASSES, REMOVED PER ACRE DURING THE PERIOD 1917–42

Species	D.B.H. class in inches											
	1–3		4–7		8–11		12–22		23 and larger		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
COMPARTMENTS 1–5												
Commercial												
Red oak*	0.4	0.1	0.5	0.9	1.1	14.7	1.8	27.7	0.6	20.7	4.4	0.9
White oak	2.9	0.7	2.4	4.4	0.7	9.3	0.4	6.2	0.7	24.1	7.1	1.4
Ash†	10.0	2.4	1.1	2.0	0.4	5.4	0.3	4.6	0.0	0.0	11.8	2.4
Basswood	30.6	7.3	5.4	9.9	0.7	9.3	1.1	16.9	1.2	41.4	39.0	8.0
Sugar maple	3.4	0.8	0.7	1.3	0.5	6.7	1.1	16.9	0.0	0.0	5.7	1.2
Elm‡	24.3	5.8	3.7	6.8	0.5	6.7	0.5	7.7	0.3	10.3	29.3	6.0
Black cherry	7.5	1.8	0.7	1.3	0.1	1.3	0.1	1.5	0.0	0.0	8.4	1.7
Black walnut	0.0	0.0	0.1	0.2	0.1	1.3	0.1	1.5	0.0	0.0	0.3	0.1
Hickory	9.6	2.3	7.4	13.5	2.5	33.3	1.0	15.5	0.1	3.5	20.6	4.2
Total	88.4	21.2	22.0	40.3	6.6	88.0	6.4	98.5	2.9	100.0	126.6	25.9
Miscellaneous												
Other§	21.3	5.1	1.0	1.8	0.0	0.0	0.1	1.5	0.0	0.0	22.4	4.6
Ironwood	308.3	73.7	31.7	57.9	0.9	12.0	0.0	0.0	0.0	0.0	340.9	69.5
Total	329.6	78.8	32.7	59.7	0.9	12.0	0.1	1.5	0.0	0.0	363.3	74.1
Grand total	418.3	100.0	54.7	100.0	7.5	100.0	6.5	100.0	2.9	100.0	489.9	100.0
COMPARTMENTS 6–10												
Commercial												
Red oak*	0.7	0.4	1.9	6.4	2.6	35.1	2.2	39.3	0.2	11.8	7.6	3.6
White oak	0.8	0.5	2.8	9.4	0.2	2.7	0.0	0.0	1.0	58.7	4.8	2.3
Ash†	6.9	4.1	0.8	2.7	0.3	4.1	0.1	1.8	0.1	5.9	8.2	3.8
Basswood	17.7	10.5	0.5	1.7	0.0	0.0	0.0	0.0	0.2	11.8	18.4	8.6
Sugar maple	4.1	2.4	1.1	3.7	1.0	13.5	0.7	12.5	0.0	0.0	6.9	3.2
Elm‡	23.3	13.8	2.3	7.8	0.3	4.1	0.1	1.8	0.2	11.8	26.2	12.3
Black cherry	15.5	9.2	0.3	1.0	0.0	0.0	0.4	7.1	0.0	0.0	16.2	7.6
Black walnut	0.0	0.0	0.0	0.0	0.0	0.0	0.5	8.9	0.0	0.0	0.5	0.2
Hickory	5.4	3.2	13.8	46.5	2.8	37.8	1.6	28.6	0.0	0.0	23.6	11.1
Total	74.4	44.1	23.5	79.2	7.2	97.3	5.6	100.0	1.7	100.0	112.4	52.7
Miscellaneous												
Other§	22.1	13.1	0.9	3.0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	10.8
Ironwood	72.3	42.8	5.3	17.8	0.2	2.7	0.0	0.0	0.0	0.0	77.8	36.5
Total	94.4	55.9	6.2	20.8	0.2	2.7	0.0	0.0	0.0	0.0	100.8	47.3
Grand total	168.8	100.0	29.7	100.0	7.4	100.0	5.6	100.0	1.7	100.0	213.2	100.0

TABLE VI (*concluded*)

Species	D.B.H. class in inches											
	1–3		4–7		8–11		12–22		23 and larger		Total	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
COMPARTMENTS 1–10												
Commercial												
Red oak*	0.6	0.2	1.0	2.4	1.7	22.8	2.0	33.3	0.4	17.4	5.7	1.6
White oak	1.8	0.6	2.4	5.7	0.5	6.7	0.2	3.3	0.8	34.8	5.7	1.6
Ash†	8.8	3.0	1.0	2.4	0.3	4.0	0.2	3.3	0.1	4.4	10.4	3.0
Basswood	24.6	8.4	3.2	7.6	0.4	5.3	0.5	8.3	0.7	30.4	29.4	8.4
Sugar maple	3.8	1.3	0.8	1.9	0.7	9.3	0.9	15.0	0.0	0.0	6.2	1.8
Elm‡	24.4	8.3	3.0	7.1	0.4	5.3	0.3	5.0	0.2	8.7	28.3	8.1
Black cherry	12.1	4.1	0.5	1.2	0.1	1.3	0.2	3.3	0.0	0.0	12.9	3.7
Black walnut	0.0	0.0	0.0	0.0	0.1	1.3	0.3	5.0	0.0	0.0	0.4	0.1
Hickory	7.6	2.6	9.5	22.6	2.7	36.0	1.3	21.8	0.1	4.3	21.2	6.0
Total	83.7	28.5	21.4	50.9	6.9	92.0	5.9	98.3	2.3	100.0	120.2	34.3
Miscellaneous												
Other§	22.3	7.6	0.9	2.1	0.0	0.0	0.1	1.7	0.0	0.0	23.3	6.6
Ironwood	187.5	63.9	19.8	47.0	0.6	8.0	0.0	0.0	0.0	0.0	207.9	59.1
Total	209.8	71.5	20.7	49.1	0.6	8.0	0.1	1.7	0.0	0.0	231.2	65.7
Grand total	293.5	100.0	42.1	100.0	7.5	100.0	6.0	100.0	2.3	100.0	351.4	100.0

* Includes black oak. † Predominantly white ash. ‡ Includes both American and red elms.
§ Includes blue beech, soft maple, butternut, hawthorn, dogwood, and sassafras.

TABLE VII

GROSS MEAN ANNUAL INCREMENT PER ACRE FOR THE PERIOD 1917–42

Item	Total basal area	Total gross volume	
	Square feet	Cu. ft.	Bd. ft.*
Compartments 1–5			
1. Stand at end of 1942	73.654	1,961.2	5,328
2. Material removed, 1917–42	41.361	1,150.4	3,029
3. Total	115.015	3,111.6	8,357
4. Stand in 1917 before cutting	83.848	2,228.0	5,932
5. Difference	32.167	883.6	2,425
6. Mean annual increment for 25 years	1.287	35.3	97
Compartments 6–10			
1. Stand at end of 1942	75.257	2,064.2	5,983
2. Material removed, 1917–42	26.199	723.0	2,105
3. Total	101.456	2,787.2	8,088
4. Stand in 1917 before cutting	78.077	2,168.5	6,391
5. Difference	23.379	618.7	1,697
6. Mean annual increment for 25 years	0.935	24.9	68
Compartments 1–10			
1. Stand at end of 1942	74.455	2,012.7	5,655
2. Material removed, 1917–42	33.782	936.5	2,562
3. Total	108.237	2,949.2	8,217
4. Stand in 1917 before cutting	80.463	2,198.2	6,162
5. Difference	27.774	751.0	2,055
6. Mean annual increment for 25 years	1.111	30.0	82

* Scribner Log Rule.